THE JOURNAL OF AGRICULTURE
OF THE UNIVERSITY OF PUERTO RICO

Issued quarterly by the Agricultural Experiment Station of the University of Puerto Rico, for the publication of articles by members of its personnel, or others, dealing with any of the more technical aspects of scientific agriculture in Puerto Rico or the Caribbean Area.

Vol. XLI July 1957 No. 3

Sugarcane Variety Trials in Puerto Rico, 1951-55

Ferdinand Méndez-Roig and George Samuels[1]

INTRODUCTION

The adoption of new varieties by the farmer has been one of the major reasons for our advancement in agriculture throughout the centuries. New varieties have given man greater yields, better quality of product, plants resistant to diseases and insects, and plants able to tolerate wide variations in climate and soil. This has been especially true of sugarcane.

The need for new sugarcane varieties has led to never-ending work of the agricultural experiment stations to provide them for the farmer. However, to insure that the varieties provided the farmer are superior in sugar-yielding power to existing varieties, that they have high disease resistance, and that they possess desirable agronomic qualities, the varieties to be compared are subjected to field trials. Since its establishment, in 1910 as the Sugar Cane Experiment Station, the Agricultural Experiment Station of the University of Puerto Rico has been devoted to the task of developing and testing new sugarcane varieties for Puerto Rican use. Today, almost 50 years later, modern scientific techniques have refined the field-testing and enabled us to make more accurate comparisons. However, the task still remains the same: to find new sugarcane varieties which will yield more sugar per acre than those now in commercial use.

PROCEDURE

The sugarcane variety trials planted and harvested for the period 1951–55 were included in 19 separate experiments totalling 33 crops (see fig. 1) located at various sites in the Island. For convenience of presentation, as well as for reader's convenience, these experiments have been grouped arbitrarily into geographic areas (see table 1). For six of the experiments a plant crop and two ratoons were harvested; two experiments included a plant cane and one ratoon; and 11 experiments were on plant canes only.

[1] Agronomists of the Agricultural Experiment Station, University of Puerto Rico, Río Piedras, P. R.

The authors wish to acknowledge the cooperation of those members of the Agronomy and Horticulture Department, past or present, and other cooperators who assisted in carrying out the fieldwork.

These 11 plant-cane experiments will be continued for two ratoons. The new data will then be reported in forthcoming variety-trial reports.

All experiments were laid out in the field in lattice designs with from six to eight replications. Twenty-five varieties were used in each experiment. The majority of the varieties used were seedlings developed by the Agricultural Experiment Station at Río Piedras. Some imported Barbados and Hawaiian varieties were also included as checks in every experiment with from one to three commercial varieties commonly grown in the area where the field trials were conducted. The commercial varieties used for comparison were M. 336, B. 37161, P.O.J. 2878, P.R. 902, and M. 275. The size of the cane plot for a replication consisted normally of four rows of

FIG. 1.—The location of the 19 sugarcane variety experiments performed by the Agricultural Experiment Station, University of Puerto Rico, Río Piedras, P. R. (1951–55).

cane 24 feet in length and 4 feet apart, comprising an area of 18 by 24 feet or approximately one one-hundredth of an acre.

The agronomic management of the cane was similar to the current commercial practices used in the area where the experiment was located. The fertilizer analyses used, rates of application, and other information pertaining to soils and rainfall were given at the bottom of the table reporting each experiment, in a footnote or otherwise.

The harvested cane from each plot was weighed using a special portable crane. From each plot 10 whole canes, minus tops, were selected at random, properly tagged, and sent to the hydraulic mill of the Station at Río Piedras for determination of their available sucrose content. All cane samples were milled not later than 24 hours after cutting.

A hydraulic Squier mill was used which had two rollers, each measuring 12 by 16 inches. These rollers averaged 6.4 revolutions per minute, using a 10-horsepower electric motor (*3*)[2]. The rollers exerted a pressure of 29

[2] Italic numbers in parentheses refer to Literature Cited, p. 160.

TABLE 1.—*Location, number of crops, soil type, and date of variety field trials with 33 crops of sugarcane in different areas of Puerto Rico*[1]

Location	Number of crops		Soil type	Years
	Plant cane	Ratoon		
East				
1. Colonia Laura, Central Roig, Yabucoa	1	0	Talante sandy loam	1953–55
2. Colonia Mandry, Eastern Sugar Associates, Humacao	1	0	Piñones clay	1953–55
3. Colonia Santa Teresa, Eastern Sugar Associates, Humacao	1	2	Josefa clay	1951–55
Northeast				
4. Colonia Buena Vista, Land Authority of P. R., Carolina	1	2	Coloso silty clay	1951–55
North Central				
5. Colonia Doña Inés, Land Authority of P.R., Vega Baja	1	0	Coloso silty clay loam	1953–55
6. Colonia Santa Rita, Central Monserrate Manatí	1	2	Toa silty loam	1952–55
7. Colonia Catalana, Land Authority of P.R., Barceloneta	1	2	Toa loam	1951–55
8. Barrio Garrochales, A. Márquez, Arecibo	1	2	Espinosa sandy clay	1952–55
9. A. Fraticelli farm, Arecibo	1	0	Coloso silty clay	1953–55
Northwest				
10. Barrio Guerrero, Agr. Exp. Substation, Isabela	1	0	Coto clay	1954–55
11. Barrio Arenales Bajo, F. Juliá, Isabela	1	1	do.	1953–55
West				
12. Colonia Librada, García Méndez, Añasco	1	0	Fortuna clay loam	1953–55
13. Comunidad Pagán, Añasco	1	0	do.	1952–54
South				
14. Hacienda Santa Rita, Land Authority of P. R., Guánica	1	0	San Antón clay loam	1953–55
15. Colonia Central, Central Rufina, Guayanilla	1	1	Santa Isabel silty loam	1952–55
16. Colonia Boca Chica, Central Mercedita, Ponce	1	0	San Antón silty clay loam	1953–55

TABLE 1.—*Continued*

Location	Number of crops		Soil type	Years
	Plant cane	Ratoon		
Interior				
17. Colonia Factoría, Eastern Sugar Associates, Cayey	1	0	Juncos clay	1953-55
18. Barrio Padilla, Agr. Exp. Station, Corozal	1	2	Lares clay	1951-55
19. Colonia Batey, Central Juncos, Juncos	1	0	Via sandy clay loam	1953-55

[1] 25 varieties were used in each experiment.

tons per square inch for the extraction of the juice from the cane passing through them. Each cane sample was milled once and the bagasse also passed through once.

All yield results were statistically analyzed. For the sake of brevity and clarity only the leading four varieties in each experiment site, plus the commercial variety used in the experiment, were then arranged in tabular form. The ranking given to the varieties in each experiment in the tables applies to the rank held when all 25 varieties were compared. Thus, if M. 336 has a rank number of 16, this means that it ranked sixteenth when compared with all 25 varieties tested in that particular trial. Least significant differences given for tons of 96° available sugar per acre are based also on all 25 varieties tested in each trial.

RESULTS

AVAILABLE 96° SUGAR

In the East, the Barbados varieties B. 37161, B. 37172, B. 40105, and B. 41227 were the leading varieties occupying first or second place in all three experiments in this area (table 2). The commercial check variety M. 336 ranked poorly, as did P.O.J. 2878.

For the one experiment in the Northeastern Area, H. 328560 ranked first with B. 41227 and B. 37161 second and third in tons of sugar yielded per acre.

B. 37161 appeared first in two of the five experiments in the North Central Area. H. 328560, P.R. 980, and B. 40105 each ranked first in single experiments. B. 41227 and B. 37172 ranked second and third in separate experiments. Commercial variety M. 336 made a poor showing in this area ranking from twelfth to seventeenth.

Location[1]	First		Second		Third		Fourth		Commercial check			L.S.D. 5-percent[3]
	Variety	Sugar	Variety	Sugar	Variety	Sugar	Variety	Sugar	Variety	Sugar	Rank[2]	
		Tons		*Tons*		*Tons*		*Tons*		*Tons*		
East												
1	B. 37161	16.2	B. 37172	14.3	P.R. 968	13.5	P.R. 1000	12.3	M. 336	11.0	10	2.35
2	B. 40105	9.4	B. 37171	9.1	B. 37161	9.0	P.R. 980	8.5	M. 336	5.5	15	1.30
3	B. 41227[4]	9.3	B. 37161	8.7	C.A. 38102	7.4	P.R. 1000	7.2	P.O.J. 2878	7.0	7	1.20
Northeast												
4	H. 328560	8.7	B. 41227	8.0	B. 37161	7.6	C.A. 38102[5]	7.3	P.O.J. 2878	6.2	12	.95
North central												
5	B. 37161	13.3	P.R. 1000	12.8	P.R. 980	12.6	P.R. 968	12.3	M. 336	8.4	12	1.25
6	B. 37161	8.9	H. 328560	8.8	C.A. 3874	8.0	B. 37172	7.9	M. 336	6.7	14	.90
7	H. 328560[5]	11.7	B. 41227	10.8	B. 37161	10.6	P.R. 1000	10.2	M. 336	6.6	16	1.55
8	P.R. 980	7.1	B. 40105	7.0	B. 41227	6.3	P.R. 963	6.3	M. 336	4.7	17	.95
9	B. 40105	17.9	B. 37172	16.7	P.R. 980	16.3	H. 328560	15.6	M. 336	10.4	16	1.60
Northwest												
10	P.R. 980	6.8	P.R. 999	6.7	B. 4362	6.7	P.R. 975	6.7	P.R. 902	5.8	9	1.00
11	P.R. 980	7.0	H. 328560	6.4	P.R. 965	6.0	P.R. 963	5.7	P.R. 902	4.5	16	.75
West												
12	P.R. 980	9.6	P.R. 968	9.4	B. 37172	8.8	P.R. 975	8.5	P.O.J. 2878	6.2	18	1.10
13	P.R. 980	8.2	B. 37161	7.4	B. 37172	7.3	P.R. 954	6.9	M. 336	4.8	14	1.15
South												
14	B. 37161	17.0	P.R. 975	15.3	B. 40105	14.8	B. 41227	14.8	M. 336	8.9	16	1.70
15	P.R. 980	11.0	B. 41227	10.4	B. 41211[5]	10.0	P.R. 1000	9.9	M. 336	7.8	20	1.25
16	P.R. 980	15.1	P.R. 975	15.0	B. 37161	14.2	H. 328560	14.2	M. 336	11.6	17	1.80
Interior												
17	P.R. 975	11.30	P.R. 980	11.3	B. 37161	11.3	B. 40105	10.6	P.O.J. 2878	8.6	16	1.05
18	H. 328560	8.6	B. 41227	8.3	B. 37161	8.1	B. 41211	8.0	M. 336	5.5	11	1.05
19	P.R. 980	6.1	B. 37172	5.3	P.R. 975	5.0	P.R. 970	5.0	M. 336	2.4	23	.90

[1] Numbers refer to locations given in table 1 and fig. 1.
[2] The rank of the commercial variety as compared with the other 24 varieties tested in that location.
[3] Least significant difference in tons of sugar per acre needed for comparing the varieties listed in that location.
[4] B. 4098 which ranked first was excluded because of its high cane-mosaic susceptibility.
[5] B. 34104 which held this rank was excluded because of its high cane-mosaic susceptibility.

The first-ranking variety for the Northwest was P. R. 980 with the check variety P. R. 902 ranking very poorly as compared to the yields of P. R. 980.

For the West, P.R. 980 was also the leading variety, with P.R. 968 and B. 37161 second and B. 37172 third. Both check varieties P.O.J. 2878 and M. 336 ranked very low in these trials.

In the irrigated cane lands of the South of Puerto Rico, P.R. 980 ranked first in two of the three experiments in this area. In the Guánica experiment (No. 14, table 2), B. 37161 ranked first. P.R. 975 held second place in the South. Check variety M. 336 did very poorly here, ranking from sixteenth to twentieth.

The Interior Area of the Island had P.R. 980, P.R. 975, and H. 328560 all in first place in separate experiments. B. 41227, B. 37172, and B. 37161 all made good showings in this area. Check variety P.O.J. 2878 and M. 336 were significantly outyielded in tons of sugar.

TONS OF CANE

High cane tonnage per acre always looks impressive to the grower. If this high tonnage is coupled with high sucrose the benefits to the grower are great. On the other hand, if high tonnage is coupled with low sucrose values, the benefits realized are less. However, for those growers whose interests are in high cane-tonnage production per acre, the results of the variety trials are summarized for tons of cane per acre in table 3.

The two outstanding varieties in tons of cane per acre were B. 37161 and P.R. 980. In the East and North Central B. 37161 made its strongest showing ranking first in four out of the eight trials, second in two trials, and fourth in one trial.

P.R. 980 was the leading variety in cane tonnage for the Northwest, West, South, and Interior Areas placing first in 8 of the 10 trials in these areas.

B. 41227 ranked first in the Northeast and in one trial in the East and Interior Areas.

H. 328560 and B. 37172 also did well in cane tonnage production.

All commercial check varieties did poorly in tons of cane per acre as compared to the leading varieties.

SUCROSE-PERCENT-CANE

Undoubtedly the production of the highest yield of sugar per acre may be the farmer's goal, but he always has shown a great preference for sugar-cane varieties with high sucrose content. This preference for a "sweet" cane variety has at times made certain varieties commercially acceptable even though their tonnage-of-cane performance was not outstanding. This

Ranking of varieties and their yields of tons of cane per acre

Location	First	Second	Third	Fourth	Commercial check

Location[1]	Ranking of varieties and their yields of tons of cane per acre										
	First		Second		Third		Fourth		Commercial check		
	Variety	Cane	Variety	Cane	Variety	Cane	Variety	Cane	Variety	Cane	Rank[2]
		Tons		*Tons*		*Tons*		*Tons*		*Tons*	
East											
1	B. 37161	115	B. 37172	106	P.R. 968	95	P.R. 1000	93	M. 336	74	11
2	B. 37161	72	B. 40105	71	B. 37172	70	P.R. 980	67	M. 336	40	19
3	B. 41227	77	B. 37161[3]	71	C.A. 38102	61	P.R. 1000	59	P.O.J. 2878	58	5
Northeast											
4	B. 41227	57	H. 328560	57	C.A. 3874	53	B. 37161	52	P.O.J. 2878	45	12
North Central											
5	B. 37161	107	P.R. 980	102	P.R. 1000	99	P.R. 968	91	M. 336	60	13
6	B. 37161	68	H. 328560	67	B. 37172	64	C.A. 3874	64	M. 336	48	18
7	H. 328560[4]	91	B. 37161	86	C.A. 3874	86	B. 41227	85	M. 336	51	16
8	P.R. 980	58	B. 40105	56	B. 41227	53	P.R. 963	51	M. 336	34	21
9	B. 40105	148	P.R. 980	131	B. 37172	128	B. 37161	126	M. 336	72	17
Northwest											
10	P.R. 980	56	B. 41227	51	P.R. 999	50	P.R. 975	49	P.R. 902	45	10
11	P.R. 980	54	H. 328560	46	P.R. 965	43	B. 40105	42	P.R. 902	34	16
West											
12	P.R. 980	63	B. 37172	60	P.R. 970	60	P.R. 968	59	P.O.J. 2878	42	17
13	P.R. 980	59	B. 37161	58	B. 37172	57	P.R. 1000	49	M. 336	30	17
South											
14	B. 37161	129	B. 40105	119	P.R. 980	114	B. 41227	113	M. 336	61	22
15	P.R. 980	94	B. 41211	88	B. 41227	87	B. 37161[4]	82	M. 336	59	23
16	P.R. 980	119	B. 37161	113	B. 37172	107	H. 371933	106	M. 336	78	20
Interior											
17	P.R. 980	78	B. 37161	77	B. 40105	73	B. 37172	73	P.O.J. 2878	61	16
18	B. 41227	70	B. 37161	65	H. 328560	63	P.R. 973	63	M. 336	48	13
19	P.R. 980	43	B. 37172	41	P.R. 999	38	P.R. 973	37	M. 336	21	22

[1] Numbers refer to locations given in table 1 and fig. 1.

[2] The rank of the commercial variety as compared with the other 24 varieties tested in that location.

[3] B. 4098 which held this rank was excluded because of its high cane-mosaic susceptibility.

[4] B. 34104 which held this rank was excluded because of its high cane-mosaic susceptibility.

The first-ranking variety for the Northwest was P. R. 980 with the check variety P. R. 902 ranking very poorly as compared to the yields of P. R. 980.

For the West, P.R. 980 was also the leading variety, with P.R. 968 and B. 37161 second and B. 37172 third. Both check varieties P.O.J. 2878 and M. 336 ranked very low in these trials.

In the irrigated cane lands of the South of Puerto Rico, P.R. 980 ranked first in two of the three experiments in this area. In the Guánica experiment (No. 14, table 2), B. 37161 ranked first. P.R. 975 held second place in the South. Check variety M. 336 did very poorly here, ranking from sixteenth to twentieth.

The Interior Area of the Island had P.R. 980, P.R. 975, and H. 328560 all in first place in separate experiments. B. 41227, B. 37172, and B. 37161 all made good showings in this area. Check variety P.O.J. 2878 and M. 336 were significantly outyielded in tons of sugar.

TONS OF CANE

High cane tonnage per acre always looks impressive to the grower. If this high tonnage is coupled with high sucrose the benefits to the grower are great. On the other hand, if high tonnage is coupled with low sucrose values, the benefits realized are less. However, for those growers whose interests are in high cane-tonnage production per acre, the results of the variety trials are summarized for tons of cane per acre in table 3.

The two outstanding varieties in tons of cane per acre were B. 37161 and P.R. 980. In the East and North Central B. 37161 made its strongest showing ranking first in four out of the eight trials, second in two trials, and fourth in one trial.

P.R. 980 was the leading variety in cane tonnage for the Northwest, West, South, and Interior Areas placing first in 8 of the 10 trials in these areas.

B. 41227 ranked first in the Northeast and in one trial in the East and Interior Areas.

H. 328560 and B. 37172 also did well in cane tonnage production.

All commercial check varieties did poorly in tons of cane per acre as compared to the leading varieties.

SUCROSE-PERCENT-CANE

Undoubtedly the production of the highest yield of sugar per acre may be the farmer's goal, but he always has shown a great preference for sugar-cane varieties with high sucrose content. This preference for a "sweet" cane variety has at times made certain varieties commercially acceptable even though their tonnage-of-cane performance was not outstanding. This

Location[1]	Ranking of varieties and their yields of tons of cane per acre										
	First		Second		Third		Fourth		Commercial check		
	Variety	Cane	Variety	Cane	Variety	Cane	Variety	Cane	Variety	Cane	Rank[2]
		Tons		*Tons*		*Tons*		*Tons*		*Tons*	
East											
1	B. 37161	115	B. 37172	106	P.R. 968	95	P.R. 1000	93	M. 336	74	11
2	B. 37161	72	B. 40105	71	B. 37172	70	P.R. 980	67	M. 336	40	19
3	B. 41227	77	B. 37161[3]	71	C.A. 38102	61	P.R. 1000	59	P.O.J. 2878	58	5
Northeast											
4	B. 41227	57	H. 328560	57	C.A. 3874	53	B. 37161	52	P.O.J. 2878	45	12
North Central											
5	B. 37161	107	P.R. 980	102	P.R. 1000	99	P.R. 968	91	M. 336	60	13
6	B. 37161	68	H. 328560	67	B. 37172	64	C.A. 3874	64	M. 336	48	18
7	H. 328560[4]	91	B. 37161	86	C.A. 3874	86	B. 41227	85	M. 336	51	16
8	P.R. 980	58	B. 40105	56	B. 41227	53	P.R. 963	51	M. 336	34	21
9	B. 40105	148	P.R. 980	131	B. 37172	128	B. 37161	126	M. 336	72	17
Northwest											
10	P.R. 980	56	B. 41227	51	P.R. 999	50	P.R. 975	49	P.R. 902	45	10
11	P.R. 980	54	H. 328560	46	P.R. 965	43	B. 40105	42	P.R. 902	34	16
West											
12	P.R. 980	63	B. 37172	60	P.R. 970	60	P.R. 968	59	P.O.J. 2878	42	17
13	P.R. 980	59	B. 37161	58	B. 37172	57	P.R. 1000	49	M. 336	30	17
South											
14	B. 37161	129	B. 40105	119	P.R. 980	114	B. 41227	113	M. 336	61	22
15	P.R. 980	94	B. 41211	88	B. 41227	87	B. 37161[4]	82	M. 336	59	23
16	P.R. 980	119	B. 37161	113	B. 37172	107	H. 371933	106	M. 336	78	20
Interior											
17	P.R. 980	78	B. 37161	77	B. 40105	73	B. 37172	73	P.O.J. 2878	61	16
18	B. 41227	70	B. 37161	65	H. 328560	63	P.R. 973	63	M. 336	48	13
19	P.R. 980	43	B. 37172	41	P.R. 999	38	P.R. 973	37	M. 336	21	22

[1] Numbers refer to locations given in table 1 and fig. 1.
[2] The rank of the commercial variety as compared with the other 24 varieties tested in that location.
[3] B. 4098 which held this rank was excluded because of its high cane-mosaic susceptibility.
[4] B. 34104 which held this rank was excluded because of its high cane-mosaic susceptibility.

TABLE 4.—*Ranking of varieties and their yields of sucrose-percent-cane for sugarcane variety trials in Puerto Rico, 1951–55*

Location[1]	Ranking of varieties and their yields of sucrose-percent-cane										
	First		Second		Third		Fourth		Commercial check		
	Variety	Sucrose	Variety	Sucrose	Variety	Sucrose	Variety	Sucrose	Variety	Sucrose	Rank[2]
		Percent		*Percent*		*Percent*		*Percent*		*Percent*	
East											
1	B. 4362	15.21	P.R. 975	14.84	M. 336	14.83	P.R. 968	14.09	M. 336	14.83	3
2	M. 336	13.71	P.R. 975	13.33	H. 328560	13.21	B. 40105	13.13	M. 336	13.71	1
3	M.L. 318	13.70	M. 336	13.66	P.R. 955	13.36	P.R. 902	12.78	P.O.J. 2878	12.01	13
Northeast											
4	M.L. 318	15.26	H. 328560	15.20	P.R. 961	15.07	P.R. 902	15.06	P.O.J. 2878	13.68	18
North Central											
5	M. 336	13.96	B. 4362	13.79	P.R. 975	13.76	H. 328560	13.65	M. 336	13.96	1
6	M. 336	14.01	P.R. 916	13.74	P.R. 929	13.30	S.H. 59–9[3]	13.25	M. 336	14.01	1
7	P.R. 961	13.84	H. 328560	12.83	M.L. 318	12.82	P.R. 955	12.79	M. 336	12.73	5
8	M. 336	13.71	P.R. 929	13.56	P.R. 907	13.53	P.R. 916	13.45	M. 336	13.71	1
9	P.R. 1007	13.97	M. 336	13.38	P.R. 967	13.37	P.R. 975	13.19	M. 336	13.38	2
Northwest											
10	B. 4362	13.69	P.R. 1007	13.69	P.R. 975	13.60	P.R. 967	13.49	P.R. 902	12.66	12
11	P.O.J. 3016	14.58	P.R. 975	14.31	P.R. 965	14.12	P.R. 929	13.98	P.R. 902	13.42	10
West											
12	P.R. 1007	16.83	P.R. 975	16.74	H. 328560	16.35	P.O.J. 3016	16.22	P.O.J. 2878	14.53	16
13	M. 336	15.58	P.R. 902	15.16	P.R. 907	15.03	P.R. 947	14.92	M. 336	15.58	1
South											
14	P.R. 975	14.81	M. 336	14.27	B. 4362	14.26	H. 328560	14.23	M. 336	14.27	2
15	P.R. 907	14.42	M. 336	13.81	P.R. 951	13.42	P.R. 929	13.23	M. 336	13.81	2
16	B. 4362	14.51	M. 336	14.37	P.R. 975	14.26	P.R. 1007	14.10	M. 336	14.37	2
Interior											
17	P.R. 975	15.97	P.R. 968	15.49	B. 4362	15.07	H. 328560	14.76	P.O.J. 2878	14.19	14
18	P.R. 984	13.85	H. 328560	13.56	M. 336	13.48	M.L. 318	13.16	M. 336	13.48	3
19	P.R. 975	14.68	P.R. 967	14.32	P.R. 968	14.20	P.O.J. 3016	13.96	M. 336	11.03	23

[1] Numbers refer to locations given in table 1 and fig. 1.

[2] The rank of the commercial variety as compared with other 21 varieties tested in that location.

desire is not without reason, for a higher sucrose-percent-cane means a more concentrated product that the farm can harvest at lower costs. In view of this, the varieties with the highest sucrose-percent-cane in each trial were averaged, and a summary of the leading varieties is presented in table 4.

For the East, M. 336, B. 4362, M.L. 318, and P.R. 975 were the leading varieties in sucrose content.

M.L. 318 ranked first for the Northeast.

The North Central had M. 336 first in three out of the five trials, second in one, and fifth in another. P.R. 975, which was tested in only two trials in this area, ranked third and fourth in these trials. For the North Central Area, M. 336 still remained the best variety for sucrose-percent-cane pro-

TABLE 5.—*Ranking of the leading varieties tested in the different cane areas of Puerto Rico, in terms of sucrose-percent-cane*

Rank	Variety	Crops	Sucrose-percent-cane	Cane per acre per month (TCAM)
		Number	*Percent*	*Tons*
1	P.R. 975	12	14.32	4.19
2	B. 4362	9	14.26	3.86
3	M. 336	13	13.97	3.44
4	P.R. 1007	10	13.93	—
5	H. 328560	14	13.85	4.55
6	M.L. 318	4	13.84	—
7	P.R. 968	10	13.78	4.28
8	P.R. 967	10	13.64	3.96
9	P.O.J. 3016	12	13.54	—

duction. B. 4362, P.O.J. 3016, P.R. 1007, and P.R. 975 held first and second places in the two trials in this area.

In the West, P.R. 1007, M. 336, P.R. 975, and P.R. 902 ranked first and second.

The South had P.R. 975 first in one trial with B. 4362 and P.R. 907 first in the other two trials. M. 336 was second in all three trials.

P.R. 975 held first place in the two trials in which it was tested in the Interior. P.R. 984 was first in the trial. P.R. 975 was not included.

When the average sucrose-percent-cane contents were found for each variety, P.R. 975 and B. 4362 showed higher values than did M. 336 (table 5).

It is interesting to note that these two other varieties, P.R. 975 and B. 4362, not only had higher sucrose-percent-cane values than the favored commercial variety M. 336, but also were higher in tons of cane per acre per month (table 5). That is to say P.R. 975 and B. 4362 not only had high sucrose contents but were also outstanding producers of cane tonnage.

[1] Numbers refer to locations given in table 1 and fig. 1.

H. 328560 also showed high sucrose and cane-tonnage production, producing 1 ton or more per month than M. 336 with a sucrose-percent-cane value only 0.12 percent less.

TONS OF SUGAR PER ACRE PER MONTH (TSAM)

Inasmuch as varietal experiments usually have different times of planting and harvesting a comparison of any two experiments on a ton-of-cane or sugar basis may be misleading. The use of tons of sugar produced per

TABLE 6.—*A ranking of sugarcane varieties planted in Puerto Rico according to sugar per acre produced per month*

Rank	Variety	Crops	Sugar per month	Rank	Variety	Crops	Sugar per month
		Number	*Tons*			*Number*	*Tons*
1	P.R. 980	18	0.679	16	P.R. 967	10	0.544
2	B. 34104[1]	11	.655	17	P.R. 965	5	.540
3	B. 37161	33	.640	18	B. 41211	16	.539
4	H. 328560	24	.629	19	B.4098	18	.523
5	P.R. 963	5	.627	20	H. 371933	20	.506
6	B. 41227	33	.609	21	P.R. 954	17	.497
7	B. 37172	19	.608	22	P.O.J. 2878	11	.492
8	P.R. 975	14	.600	23	P.R. 973	25	.488
9	B. 40105	21	.598	24	P.R. 970	10	.481
10	P.R. 968	10	.589	25	M. 336	25	.480
11	P.R. 962	14	.557	26	P.R. 902	20	.478
12	C.A. 38102	14	.554	27	P.R. 961	13	.453
13	P.R. 1000	33	.554	28	P.R. 999	12	.439
14	C.A. 3874	17	.550	29	P.R. 905	4	.432
15	B. 4362	10	.549	30	M. 275	3	.332

[1] This variety is highly mosaic-susceptible. It should not be planted since this high yield was obtained with healthy planting material which is practically impossible to maintain in large-scale plantings.

acre per month as a basis allows a more suitable comparison to be made of variety experiments for any area or even between different sugar-producing countries.

The different varieties used in the experiments were ranked according to their production in tons of sugar per acre per month, after correcting for variations due to experiment location. The results are given in table 6.

P.R. 980 ranked first with an average yield of 0.679 ton for the 18 trials in which it was used out of a total of 38 trials performed. B. 37161 was second, having been used in every trial. B. 41227 and P.R. 1000 also were used in all 38 trials and ranked sixth and thirteenth, respectively. Of the commercial varieties used as checks, B. 37161 ranked third, P.O.J.

2878 was twenty-second, M. 336 twenty-fifth, P.R. 902 twenty-sixth, P.R. 905 twenty-ninth, and M. 275 thirtieth.

The first eight varieties produced 0.60 ton and over of sugar per acre per month, a commendable rate of sugar production. Varieties which produced

TABLE 7.—*Production of sugar per acre per month of some commercial and experimental cane varieties planted in Puerto Rico*

Varieties	Area planted (census 1955)[1]	Part of total area planted	Sugar per acre per month produced in experiments
	Acre	*Percent*	*Tons*
Commercial			
P.O.J. 2878	187,813	51.7	0.492
B. 37161[2]	41,060	11.3	.640
M. 336	35,149	9.7	.480
P.R. 902	11,012	3.0	.478
B.H. 10(12)	7,981	2.2	.402
M. 275	7,184	2.0	.332
P.O.J. 2725	5,379	1.5	.290
B. 34104[3]	5,006	1.4	.655
Experimental			
P.R. 980	284	0.07	.679
B. 37161	41,060	11.3	.640
H. 328560	2,637	.72	.629
P.R. 963	—	(4)	.627
B. 41227	1,251	.34	.609
B. 37172	396	.10	.608
P.R. 975	—	(4)	.600
B. 40105	239	.06	.598

[1] Based on variety census 1955 performed by Agricultural Economics and Rural Sociology Department, University of Puerto Rico, Río Piedras (*1*), P.R.

[2] B. 37161 was considered an experimental variety at the beginning of these field trials (1951). However, its rapid adoption by growers in the past 5 years gives this variety the status of a commercial cane.

[3] B. 34104 was considered an experimental cane variety at the beginning of these field trials (1951). Because of its high susceptibility to cane mosaic it was discarded by the Station from trials after 1953. However, despite the warnings of the Station, many growers adopted it for commercial use with disastrous results. At present almost all the cane of this variety still standing in Puerto Rico is ratoon cane.

[4] Less than 0.01 percent.

from 0.50 to 0.60 ton of sugar per acre per month ranked from ninth to twentieth. Producing below 0.50 ton were all commercial varieties tested, except B. 37161.

DISCUSSION

The results of these sugarcane variety trials cannot be considered satisfactory until the leading varieties have been accepted and planted by the

growers as commercial varieties. Unfortunately, in the past few decades the sugarcane growers in Puerto Rico have been slow in accepting new sugarcane varieties. Since the devastating sugarcane-mosaic epidemic of 1917–20, P.O.J. 2878 has emerged as the most popular cane variety in Puerto Rico. Resistance to change by many of the growers, especially those with small farms, has kept this variety in the majority of the cane acreage, even though many new varieties introduced and tested by the Agricultural Experiment Station has proven superior to it.

Table 7 shows the percentage distribution (1955–56) of commercial cane varieties in Puerto Rico. The production of these (in tons of sugar per acre per month) when used as check commercial varieties in the trials, is compared with the results secured with the leading experimental varieties. It is evident that all experimental varieties recommended are far superior in sugar production to the commercial varieties. Aside from B. 37161, which has gained some commercial acceptance (11.3 percent of total acreage), all commercial varieties now growing produce less than 0.50 ton of sugar per acre per month.

P.O.J. 2878 still occupies about 52 percent of the cane acreage of Puerto Rico. Grower reluctance to plant new varieties is such that the cane census of 1955–56 showed 91 percent of the cane land in Puerto Rico was in ratoons, almost all of which were of the older, poorer yielding commercial varieties. It has been calculated (*2*) that if the acreage planted to the older cane varieties were planted to the new leading experimental varieties presented, the present sugar produced in Puerto Rico could be grown on about two-thirds of the present cane acreage. Thus over 100,000 acres now in cane could be diverted to other urgently needed crops in Puerto Rico without decreasing sugar production.

The Agricultural Experiment Station of the University of Puerto Rico will continue to breed, introduce, and test better cane varieties for our Puerto Rican farmers. It remains for these farmers to accept these new varieties commercially so that they may obtain higher yields and greater profit on fewer acres.

SUMMARY

Sugarcane variety trials performed by the Agricultural Experiment Station, University of Puerto Rico, Río Piedras, P. R., During the period 1951–55, involved 19 separate experiments and 33 crops. The following results are significant:

1. In the production of available 96° sugar per acre B. 37161 was the outstanding variety of East and North Central cane areas of the Island. P.R. 980 was the leading variety in the Northwest, West, South, and Interior of Puerto Rico.

2. B. 40105, B. 37172, B. 41227, H. 328560, and P.R. 975 all were among the leading producers in tons of sugar per acre.

3. The check varieties M. 336, P.O.J. 2878, and P.R. 902, ranked poorly in the trials as compared with the leading varieties in tons of sugar produced per acre.

4. In terms of tons of cane per acre B. 37161 and P.R. 980 were the two leading varieties for the entire Island, with H. 328560, B. 41227, and B. 37172 also showing favorable cane-tonnage figures. All check varieties did poorly in tons of cane per acre as compared to the leading variety.

5. The varieties were also ranked according to their production of sucrose-percent-cane. P.R. 975 and B. 4362 were first and second, respectively. These two varieties also produced higher cane tonnage than the favored commercial variety M. 336, which ranked third.

6. Finally, the varieties were ranked according to the tons of sugar per acre produced per month, and P.R. 980 ranked first. The first eight experimental varieties produced over 0.60 ton of sugar per acre per month as compared with all commercial varieties, except B. 37161, which produced below 0.50 ton of sugar per acre per month.

7. The reluctance of Puerto Rican farmers to adopt the new cane varieties tested and proven superior to the old commercial varieties is very unprofitable to them. Yields are cited which show that if the land now used to grow the older cane varieties were planted to the new leading experimentally tested varieties discussed in this article, the present sugar crop in Puerto Rico could be produced on about two-thirds of the present acreage. This would release over 100,000 acres for other agricultural uses.

RESUMEN

Las pruebas con variedades de caña de azúcar llevadas a cabo por la Estación Experimental Agrícola de la Universidad de Puerto Rico, Río Piedras, P. R., durante el período de 1951–55, incluyeron 19 experimentos separados y 33 cosechas. Los siguientes resultados son significativos:

1. En la producción de azúcar 96° disponible por acre, la variedad B. 37161 fué la más sobresaliente en las áreas de caña del Este y del Norte de la Isla. La P.R. 980 fué la más sobresaliente en las áreas del Noroeste, Oeste, Sur, e Interior de Puerto Rico.

2. Las variedades B. 40105, B. 37172, B. 41227, H. 328560, y P.R. 975 figuraron entre las mejores productoras de toneladas de azúcar por acre.

3. Las variedades M. 336, P.O.J. 2878, y P.R. 902, usadas como testigo, hicieron una pobre demostración en las pruebas, comparadas con las variedades sobresalientes en la producción de toneladas de azúcar por acre.

4. En términos de toneladas de caña por acre, las variedades B. 37161 y P.R. 980 fueron las dos más sobresalientes en toda la Isla, siguiéndoles con

altos tonelajes de caña las variedades H. 328560, B. 41227 y B. 37172. Todas las variedades usadas como testigo tuvieron rendimientos pobres de toneladas de caña por acre comparadas con las variedades sobresalientes.

5. Las variedades también fueron clasificadas de acuerdo a su producción de sacarosa en caña. P.R. 975 y B. 4362 ocuparon el primer y segundo lugar, respectivamente. Estas variedades también tuvieron mayores rendimientos en tonelaje de caña que la variedad comercial preferida M. 336, que figuró en tercer lugar.

6. Finalmente, las variedades fueron clasificadas según las toneladas de azúcar producidas por acre por mes y P.R. 980 ocupó el primer lugar. Las primeras ocho variedades sobresalientes produjeron por sobre 0.60 toneladas de azúcar por acre comparadas con todas las variedades comerciales (con excepción de la B. 37161) que produjeron por debajo de 0.50 toneladas de azúcar por acre por mes.

7. La renuencia de los agricultores puertorriqueños a adoptar las nuevas variedades de caña probadas y que han demostrado ser superiores a las viejas variedades comerciales, está resultando contraproducente. Según los datos sobre rendimientos lo demuestran, si la tierra que en la actualidad está sembrada de variedades viejas se sembrara con las nuevas variedades probadas experimentalmente que se presentan en esta publicación, la producción actual de azúcar en Puerto Rico podría lograrse en alrededor de dos terceras partes de la tierra que ahora está sembrada de caña. Esto permitiría que sobraran alrededor de 100,000 acres para otros usos agrícolas.

LITERATURE CITED

1. Bayrón-Montalvo, H., and Ríos, J. M., Sugarcane varieties grown in Puerto Rico for the 1955 crop, Agr. Ec. and Rural Sociol. Dept., Agr. Exp. Sta., Univ. P. R., Sept. 1956, (unpublished).
2. Méndez, F., Posibilidad de aumento en la producción de azúcar por cuerda en Puerto Rico. Talk presented before annual assembly 1955 Sugarcane Technologists of Puerto Rico, December 10, 1956 (mimeographed).
3. Samuels, G., Influence of fertilizers on the components of available sucrose-percent-cane, *J. Agr. Univ. P. R.* **39**(2) 84–91, 1955.

The Distribution of Ascorbic Acid, Dehydroascorbic Acid, and Diketogulonic Acid in the Acerola Fruit at Different Stages of Development[1]

Alice del Campillo and Conrado F. Asenjo[2]

INTRODUCTION

Ascorbic acid (AA), dehydroascorbic acid (DHA), and 2,3-diketogulonic acid (DKA) usually occur in this decreasing order in fresh plant tissue.

The reaction AA $\rightleftarrows$ DHA is freely reversible in plant as well as in other living tissues. Ascorbic acid oxidase (*1*)[3] directly, and at least four other enzyme systems (*2*, *3*, *4*, *5*) indirectly, are known to catalyze this reaction *in vivo*. Hydrogen sulfide, among other reagents, may be used to reduce the oxidized form in the laboratory. However, the dehydro form, except in rather acid solution, undergoes *in vitro*, and probably also *in vivo*, a nonenzymatic hydrolysis at the lactone ring with the formation of diketogulonic acid. The reverse of this reaction does not occur in living tissue, as far as is known, although it can be accomplished *in vitro*. Considering the high ascorbic acid content of the acerola fruit (*Malpighia punicifolia* L.) (*6*), the following investigation was undertaken in order to determine the distribution of the three acids in this unusual fruit. No information was found in the literature regarding the distribution of AA, DHA, and DKA in the acerola fruit at different stages of development.

OBJECTIVE

It was the purpose of this investigation to determine the quantities of AA, DHA, and DKA present in the acerola fruit from its very early flowering stage to the fully developed ripe fruit. Observations were made on fresh fruits as well as on fruits that had been frozen in a deep freeze for several days.

MATERIAL AND METHODS

In order to undertake this study, we arbitrarily divided the development of the acerola fruit into five stages: Stage 1, flower bud; stage 2, rudimentary

[1] This research was made possible by a grant made to one of us (C.F.A.) by the Guggenheim Foundation. The technical assistance of Evangelina Recio is gratefully acknowledged.

[2] Department of Biochemistry and Nutrition, School of Medicine, School of Tropical Medicine, San Juan 22, P. R.

[3] Italic numbers in parentheses refer to Literature Cited, pp. 165–6.

fruit; stage 3, green fruit, about 40 percent of final size; stage 4, green fruit, about 70 percent of final size; stage 5, red-ripe mature fruit[4].

The method used for the differential determination of AA, DHA, and DKA was that of Roe, Mills, Oesterling, and Damron (*7*). It is based on the principle that 2,4-dinitrophenylhydrazine condenses with DHA and DKA but not with AA. In order to differentiate the three acids three tubes containing the same aliquot of the unknown were used. The aliquot in tube 1 was reduced with hydrogen sulfide, that in tube 2 was left untreated, and the one in tube 3 was oxidized with bromine. After coupling with 2,4-dinitrophenylhydrazine had been accomplished, the condensation derivative obtained from the first tube was a measure of the DKA; that from the second tube of the DHA and DKA; and that from the third tube of the AA, DHA, and DKA. Therefore, by subtracting the first result from the second, and the second from the third, the quantity of DHA and AA, respectively, present in the sample, was calculated.

The detailed procedure was as follows: 1 gm. of the fruit[5] was extracted in a chilled mortar with cold 5-percent thiourea-5-percent metaphosphoric acid mixture[6] using small volumes to start, *i.e.*, 3 ml. A good homogenate was obtained; the extraction was carried out for about 3 minutes. About 3 ml. more of the thiourea-metaphosphoric acid mixture was added, and the extraction was continued for another 3 minutes. This procedure was repeated again using 3 ml. of thiourea-metaphosphoric acid. The homogenate was then made up to 20 ml. by adding more of the thiourea-metaphosphoric acid mixture, and an additional 80 ml. of 5-percent metaphosphoric acid, so that the final concentration was 1-percent thiourea and 5-percent metaphosphoric acid. The green suspension was then filtered through fluted paper. The filtrate was fairly clear and was kept cold.

DETERMINATION OF DIKETOGULONIC ACID

Twenty-five milliliters of the clear filtrate was gassed for 10 minutes with hydrogen sulfide while keeping the filtrate in an ice-bath. The solution saturated with hydrogen sulfide was then gassed with carbon dioxide for 15 to 25 minutes. Two aliquots were taken for the assay.

DETERMINATION OF DHA AND DKA

The filtrate was used after the extraction and before gassing with hydrogen sulfide. Two aliquots were taken for the assay.

[4] We are indebted to the Acerola Processing Corp. for permitting us to collect the fruits used in this investigation at their plantation at Sabana Seca, P. R.

[5] Stems were removed; after stage 2 the seeds were removed and the pulp alone was used.

[6] Roe and Oesterling (*8*) found that the addition of thiourea to the metaphosphoric acid solution used for extracting plant tissues prevented the oxidation of AA to DHA and kept at a minimum the spontaneous change of DHA to DKA.

DETERMINATION OF AA, DHA, AND DKA

The remainder of the hydrogen sulfide-gassed solution was gassed with carbon dioxide and then aerated for about 5 minutes. A few drops of bromine were added until a yellow color persisted. The excess bromine was removed by aeration. A white precipitate of bromothiourea was obtained occasionally which was removed by filtration. This precipitate did not affect

TABLE 1.—*Distribution of DHA, DKA, and AA in fresh and frozen acerola fruits at different stages of development*

Stage of development	Samples	DHA	DKA	AA	Total as AA	DHA	DKA	AA
		Fresh fruits						
	Number	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Percent*	*Percent*	*Percent*
1, Flower bud	4	25.5	18.3	544.9	588.7	4.2	3.1	92.7
2, Rudimentary fruit	4	54.1	43.5	2,167.5	2,265.1	2.4	1.9	95.7
3, Green fruit 40 percent of mature size	3	166.0	109.2	2,503.3	2,778.5	6.0	3.9	90.1
4, Green fruit 70 percent of mature size	3	98.9	75.5	2,802.0	2,976.4	3.3	2.5	94.2
5, Red-ripe mature fruit	3	92.0	59.2	1,759.0	1,910.2	4.8	3.1	92.1
		Frozen fruits						
1, Flower bud	3	297.5	336.3	29.5	663.3	44.8	50.7	4.5
2, Rudimentary fruit	5	364.3	333.7	1,468.0	2,166.4	16.8	15.5	67.7
3, Green fruit 40 percent of mature size	3	57.2	123.2	2,378.0	2,558.7	2.2	4.8	93.0
4, Green fruit 70 percent of mature size	4	81.2	138.6	2,505.0	2,724.8	3.0	5.0	92.0
5, Red-ripe mature fruit	5	87.5	123.4	1,412.0	1,622.9	5.4	7.6	87.0

the final results. Two aliquots were taken for the assay. Each of the aliquots was made up to 4 ml. with the 1-percent thiourea and 5-percent metaphosphoric acid mixture. Two drops of 10-percent thiourea in 50-percent ethanol (optional in this case) were added to each tube. One milliliter of 2-percent dinitrophenylhydrazine in 9 N sulfuric acid was added to the experimental tube. The tubes were incubated overnight at room temperature and then the color was developed by adding 85-percent H_2SO_4.

A standard solution of ascorbic acid, 0.2 mg. per ml. in 5-percent metaphosphoric acid, was diluted 1:40 with 5-percent metaphosphoric acid and a 4-ml. aliquot was taken for the assay; 4 ml. = 20 μg. ascorbic acid.

RESULTS

The results are given in table 1. The values obtained for AA, DHA, and DKA at different stages of growth indicated that ascorbic acid is fairly stable, and that DHA and, especially DKA, are products of decomposition rather than of normal metabolism, as was suggested by Damron, *et al.* (*9*) in animal tissues. In general, there is more DHA than DKA in the fresh fruits, and more DKA than DHA in the frozen ones. In the formed fruit (stages 3, 4, and 5) the percentage of DHA and DKA ranged from 4 to 10 percent in fresh fruits, whereas in frozen ones it ranged from 7 to 13 percent. In the flower buds (stage 1) and rudimentary fruit (stage 2) freezing caused a marked conversion of the ascorbic acid into DHA and DKA, ranging from 32 to 95 percent.

DISCUSSION

These results indicate that the fresh fruit contains 1 to 4 percent of the total ascorbic acid present as the biologically inactive DKA. This value increases on freezing the fruit, as can be seen in table 1. In general, our results are in agreement with those obtained by Mills, *et al.* (*10*) for the determination of DHA, DKA, and AA in fresh and processed foods. They found that the majority of fresh foods assayed showed less than 5 percent of the total vitamin C-like compounds present as DKA. Processed foods contained more of the oxidized forms of ascorbic acid, and dehydrated foods showed the greatest amount of the inactive DKA.

The data collected have clearly shown that after stage 1, the fresh fruit starts to accumulate ascorbic acid at a very rapid rate; from 544.9 mg. per 100 gm. at stage 1 to 2,167.5 mg. per 100 at stage 2, an increase of the order of 300 percent. Similar changes were observed in the frozen fruit. This sudden appearance of large quantities of ascorbic acid could possibly indicate that the enzymatic system responsible for ascorbic acid synthesis reaches its optimum efficiency at this early stage of fruit development. The ascorbic acid present at stage 1 is about 19 percent of the maximum attained at stage 4, however at stage 2 it is already nearly 78 percent, while at stage 5 the content of ascorbic acid starts to decline, probably due to decomposition, and that left is only 63 percent of the maximum. The same sequence of events holds true of the frozen fruits.

SUMMARY

1. The values obtained for ascorbic acid (AA), dehydroascorbic acid (DHA), and diketogulonic acid (DKA) at different stages of growth of the fruit indicated that ascorbic acid is fairly stable in the acerola fruit and that the small content of DHA and DKA, especially of the second, are products of decomposition rather than of normal metabolism.

2. In the fresh fruit at all stages of development the content of AA was never below 90 percent of the sum of the three components studied. DHA or DKA never attained individual values above 6 percent; however, the content of DHA was always slightly greater than that of DKA.

3. In the frozen bud and rudimentary fruit there was a very significant increase in DHA and DKA and a corresponding reduction in AA. However, at higher stages of development AA was always in the neighborhood of 90 percent. There was more DKA than DHA in the frozen fruit.

4. During the formation of the rudimentary fruit (stages 1 to 2) there was a rapid increase in ascorbic acid, probably due to an optimum condition of the enzymatic system in the fruit responsible for ascorbic acid synthesis.

5. In the red-ripe fruit there was a significant lowering of ascorbic acid content.

RESUMEN

1. Los valores obtenidos para los ácidos ascórbicos (AA), dehidroascórbico (ADH) y dicetogulónico (ADC) durante las diferentes etapas del desarrollo de la fruta indicaron que el AA era bastante estable en la fruta de la acerola y que el pequeño contenido de ADH y ADC, especialmente del segundo, son productos de descomposición más que de metabolismo.

2. En la fruta fresca, en todas las etapas de crecimiento estudiadas, el contenido de AA nunca fué menor del 90 por ciento de la suma de los tres compuestos estudiados. ADH o ADC nunca llegaron a tener valores individuales sobre 6 por ciento, sin embargo, el contenido de ADH fué siempre algo mayor que el de ADC.

3. En los botones de flor o en las frutas rudimentarias congeladas se observó un aumento muy significativo en ADH y ADC y una disminución correspondiente en AA. Sin embargo, en etapas más avanzadas de crecimiento, AA siempre se mantuvo en la vecindad del 90 por ciento. En el caso del fruto congelado el ADC se encuentra en cantidad algo mayor que el ADH.

4. Durante la formación del fruto rudimentario (etapa 1 a 2) se observó un rápido aumento en AA, debido probablemente a condiciones óptimas en el sistema encimático responsable de la síntesis de ácido ascórbico en el fruto.

5. En el fruto maduro se observó una disminución significativa de ácido ascórbico.

LITERATURE CITED

1. Tauber, H., Kleiner, I. S., and Mishkind, D., Ascorbic acid (vitamin C) oxidase, *J. Biol. Chem.*, **110** 211–8, 1935.

2. Szent-Gyorgi, A., Observations on the function of peroxidase systems and the chemistry of the adrenal cortex, *Biochem. J.*, **22** 1387–1409, 1928.

3. Huszak, István (Stefan), The function of the peroxidase systems of plants, *Z. Physiol. Chem.*, **247** 239–47, 1937.
4. Johnson, S. W., and Zilva, S. S., The relation between the rate of enzymic oxidation and the stereochemical structure of ascorbic acid and its analogues, *Biochem. J.*, **31** 1366–74, 1937.
5. Keilin, D., and Hartree, E. F., Cytochrome oxidase, *Proc. Roy. Soc. London*, **125B** 171–86, 1938.
6. Asenjo, C. F., and Freire de Guzmán, A. R., The high ascorbic acid content of the West Indian cherry, *Sci.* **103** 219, 1946.
7. Roe, J. H., Mills, M. B., Oesterling, M. J., and Damron, C. M., The determination of diketo-l-gulonic acid, dehydro-l-ascorbic acid, and l-ascorbic acid in the same tissue extract by the 2,4-dinitrophenylhydrazine method, *J. Biol. Chem.*, **174** 201–8, 1948.
8. Roe, J. H., and Oesterling, M. J., The determination of dehydroascorbic acid and ascorbic acid in plant tissue by the 2,4-dinitrophenylhydrazine method, *J. Biol. Chem.*, **152** 511–17, 1944.
9. Damron, C. M., Mills, M. M., and Roe, J. H., Metabolism of l-ascorbic acid, dehydro-l-ascorbic acid, and diketo-l-gulonic acid in the guinea pig, *J. Biol. Chem.*, **195** 599–606, 1952.
10. Mills, M. M., Damron, C. M., and Roe, J. H., Ascorbic acid, dehydroascorbic acid, and diketogulonic acid in fresh and processed foods, *Anal. Chem.* **21** 707–9, 1949.

Lack of Response of Some Food Crops to the Application of Synthetic Soil Conditioners to A Clay Soil in Lajas Valley

M. A. Lugo-López, J. A. Bonnet, M. Rico-Ballester, and G. Acevedo[1]

INTRODUCTION

The soils of the Lajas Valley in southwestern semiarid Puerto Rico present unique problems of soil management and use, particularly since the development of irrigation facilities in that area (*2*)[2]. They are deep, have a uniformly high clay content, and a very high proportion of small pores through which water moves rather sluggishly. Many of them present practical drainage and salinity problems (*4*).

A rather intensive program of research is under way to determine the soil- and crop-management techniques that will provide for the maximum utilization and conservation of those soils. The rather recent development of synthetic soil conditioners claimed to improve soil physical conditions suggests study of them and their effects.

This paper reports on a field experiment designed to determine the influence of synthetic soil conditioners on soil properties and crop yields under the conditions prevailing in the Lajas Valley.

MATERIALS AND METHODS

The experimental field was located on the farm of the Agricultural Experiment Substation on the outskirts of the town of Lajas in southwestern Puerto Rico. The soil is a typical Santa Isabel clay, a compact soil of the terraces and alluvial fans, probably a Reddish Chestnut or Planosol. The surface soil is black (5 YR 2/1) with a moderately developed structure changing to dark reddish-brown (5 YR 3/3) at a 13-inch depth. The aggregates are medium to large and rather densely packed, particularly at lower depths. It turns reddish-brown or yellowish-brown at 45 inches, with many small water-worn pebbles embedded in the clay matrix. Permeability is slow or very slow and the majority of the pores are very small (*3*). The soil contains abundant feldspars of the oligoclase, albite, and labradorite varieties with kaolin and illite dominating the clay fraction (*6*).

[1] Associate Soil Scientist, Head of the Department of Soils, Research Assistant in Agronomy, and Research Assistant in Soils, respectively, Agricultural Experiment Station, University of Puerto Rico, Río Piedras and Lajas, P. R. Appreciation is expressed to R. Vázquez, who helped in laying out the experiment, and to R. Pérez-Escolar who determined the stability of the soil aggregates.

[2] Italic numbers in parentheses refer to Literature Cited, p. 172.

The experiment was laid out following a balanced incomplete block design with 13 treatments, including control untreated plots, replicated four times in a 13-block arrangement. The plots were 4 feet × 6 feet in size. The materials used were formulations 6 and 9 of Krilium, dry powder, 100-percent active ingredient; Aerotil, dry powder, 40-percent active ingredient; and Goodrite, flakes, 87-percent active ingredient. Each chemical was used at three rates: 900, 1,800, and 3,600 pounds to the acre. The conditioners were applied on May 25, 1954, and were carefully mixed with the uppermost 6 inches of soil. The check plots received the same mechanical treatment as the conditioner-treated plots to minimize any possible differences other than those imposed by treatment.

Three crops were grown on the same plots in the following sequence: Tomatoes, white beans, and sweetpotatoes. The plots were irrigated whenever indicated by a 9-inch deep-mercury tensiometer. Tomatoes, Plamar variety, were planted on June 24, 1954, at a distance of 2 feet. A 9–10–5 fertilizer was applied at the rate of 800 pounds to the acre. The plants were sprayed several times during the season with DDT and Copper A compound to keep pests under control. The tomatoes were harvested on August 28, September 2, 9, and 17, and October 1, 4, 11, and 18, 1954. The plots received 28 inches of rain and 8 inches of irrigation water. White beans, Bonita selection, were planted on November 2 at a 4-inch distance, and received the same fertilizer as did the tomatoes. After 2 weeks the plants were thinned to two per hill. They were sprayed with a 4-percent solution of DDT twice during the growing period. The beans were all harvested on January 1, 1955. An irrigation of 2 inches of water was given to supplement the 4.5 inches of rainfall, of which 3.5 fell during the month of November.

Sweetpotatoes, variety UPR No. 3, were planted on July 1, 1955. They were fertilized with an 8–8–13 fertilizer at the same rate as the previous two crops. Pests were kept under control by spraying with Aldrin, DDT, and BHC at various times during the growing period. On November 15–16, the sweet potatoes were harvested. The 30 inches of rain during the growing season were supplemented with 8 inches of irrigation water.

Undisturbed soil cores were taken to a depth of 3 inches, as well as disturbed soil samples from selected plots on November 15, 1955, prior to harvesting the sweetpotato crop, and some 18 months after applying the treatment differentials. Aggregate stability of the 3–2 mm.-size fraction was determined according to the procedure of Bryant, Bendixen, and Slater (*5*). Quick drainage, porosity, bulk density, and water retention at pF 1.78 were determined by standard procedures.

RESULTS AND DISCUSSION

Table 1 presents data on the production of tomatoes, white beans, and sweetpotatoes. The over-all differences of the treated over the check plots were not significant. The yields of Plamar tomatoes, the first crop in the sequence, were rather poor. The plants were healthy when transplanted, but they were badly attacked by fungi diseases, especially by stem rot, mainly because of the heavy August and September rains (over 16 inches,

TABLE 1.—*Mean yields of tomatoes, white beans, and sweetpotatoes grown consecutively on Santa Isabel clay treated with soil conditioners*

Treatment No.	Treatment	Rate	Crop yields in hundredweights to the acre of—		
			Tomatoes	Beans	Sweet-potatoes
		Pounds per acre			
1	Check	0	10.4	18.6	126.7
2	Krilium 9	3,600	31.3	19.5	139.0
3	do.	1,800	18.2	16.3	112.0
4	do.	900	13.6	14.6	128.7
5	Krilium 6	3,600	17.7	16.4	153.4
6	do.	1,800	13.2	19.5	149.7
7	do.	900	12.6	19.1	121.1
8	Aerotil	3,600	15.4	16.3	155.7
9	do.	1,800	10.0	16.4	119.8
10	do.	900	7.7	16.5	137.9
11	Goodrite	3,600	20.9	18.2	121.4
12	do.	1,800	30.4	19.5	129.4
13	do.	900	13.2	16.8	166.8
L.S.D. at the 5-percent level			21.7	4.1	81.0
L.S.D. at the 1-percent level			29.0	5.5	109.1

more than half of total rain during the growing period). The rather intensive spraying program could not keep these infections under control because of the frequent showers. The yields of Bonita white beans were good for all plots and no differences could be attributed to the treatment differentials. Total yields of sweetpotatoes surpassed 5 tons to the acre, in all cases with a large proportion of them well-shaped and marketable.

Lugo-López, *et al.* (*7*), working in the vicinity of Corozal, measured the beneficial effects of soil conditioners upon some crops, particularly on root crops like sweetpotatoes. Pérez-Escolar and Lugo-López (*8*) at Aibonito, obtained increases in potato yields from conditioner-treated plots, but found that stringless bean yields on the same plots were unaffected by

treatments. The responses obtained at these two locations were explained on the basis of the increased stability of soil structural units produced by the addition of conditioning chemicals. At Corozal the stability of Lares clay aggregates was increased from 25 to 32 and over 45 percent, depending upon the chemicals used. At Aibonito, the water-stable aggregates of Juncos clay increased from almost 67 percent in the untreated plots to 73–91 percent, depending on the chemicals used and their concentrations. At the latter location, no responses were obtained with the bean crop in

TABLE 2.—*Water-stable aggregates in a Santa Isabel clay soil treated with structure-stabilizing chemicals*

Treatment	Rate	3-2 mm. water-stable aggregates
	Pounds per acre	*Percent*
Check	0	57
Krilium 9	3,600	63
Krilium 6	3,600	57
Aerotil	3,600	62
Goodrite	3,600	50

TABLE 3.—*Bulk-density and soil-moisture data of a Santa Isabel clay with and without Krilium 9 present*

Treatment	Rate	Bulk density	Water drained at 60-cm. tension in 15 minutes	Maximum saturation	Water retained at pF 1.78
	Pounds per acre	*Gm./cc.*	*Percent*	*Percent*	*Percent*
Check	0	0.96	5.2	64.6	51.0
Krilium 9	3,600	.83	7.2	65.2	46.5
Do.	1,800	.94	5.6	62.8	50.7
Do.	900	.91	5.8	65.4	48.8

contrast to the potato crop. This stresses the significance of recognizing plant differences when assessing the influence of improved soil physical conditions upon crop growth and production (*8*).

The soil conditioners did not affect the stability of Santa Isabel clay soil aggregates in the experimental plots at the Lajas Substation farm, as shown in table 2.

Table 3 shows that the bulk density and water movement and retention in the upper 3 inches of Santa Isabel clay were not affected by soil conditioners. The structural units of the uppermost 6-inch layer of this soil have a naturally rather high water stability which cannot, and need not be further increased with chemical additives. Some of the soils of the

Lajas Valley have an upper layer, sometimes extending down to 24 inches, with a very high fertility level, that can maintain a somewhat favorable physical condition due to the high percentage of stable aggregates. Other soils present more difficult management problems, including salinity and alkalinity hazards.

Under such conditions the action of synthetic soil conditioners may promote increased soil-aggregate stability and improved soil physical conditions (*1*). However, the very high costs of these products will for some time limit their widespread use in general farming, even in areas where problem soils could be improved by their action. There is need of more fundamental information concerning soil properties, particularly soil structure and aggregate stability, prior to the extension of research or action programs with synthetic soil conditioners of the type tested in these experiments. The possibilities of using cheaper materials of organic origin should not be overlooked.

SUMMARY

Data are presented here from a field experiment where Krilium 6 and 9, Aerotil, and Goodrite (dry powder of the first three and flakes of the fourth) were applied to the uppermost 6 inches of a Santa Isabel clay soil at the Lajas Valley, each at rates of 900, 1,800, and 3,600 pounds to the acre. Three crops: Tomatoes, white beans, and sweetpotatoes, were grown in the sequence following the establishment of the treatment differentials. None of the crops showed any response to the soil-conditioning chemicals. The stability of the soil aggregates of Santa Isabel clay, which is naturally high, was not affected by the treatment. The data presented show also that the water movement and retention and other soil physical properties remain unaffected by treatment. The lack of response is discussed and compared with other problem soils where crop responses have been measured.

RESUMEN

Se presentan aquí datos sobre un experimento de campo donde se aplicó Krilium 6, Krilium 9, Aerotil, y Goodrite (los tres primeros en polvo seco, y el ultimo en hojuelas) a las primeras 6 pulgadas del suelo Santa Isabel arcilloso en el Valle de Lajas.

Se produjeron consecutivamente tomates, habichuelas blancas y batatas mameyas en las parcelas después de establecer los tratamientos. Ninguna de estas cosechas respondió en lo más mínimo al tratamiento con acondicionadores de suelos. Estos resultados se discuten a la luz de los obtenidos en otros suelos problemas donde hubo aumentos en los rendimientos y considerando que la estabilidad de las unidades estructurales del suelo

Santa Isabel arcilloso es alta por naturaleza y no fué afectada por los tratamientos. Se presentan además datos que demuestran que el movimiento y retención de humedad, así como otras propiedades físicas del suelo, no fueron afectados por los tratamientos con los acondicionadores de suelos usados.

LITERATURE CITED

1. Allison, L. E., Effect of synthetic polyelectrolytes on the structure of saline and alkali soils, *Soil Sci.* **73**(6) 443–54, 1952.
2. Bonnet, J. A., and Tirado Sulsona, P., Soil Studies in the Lajas Valley. Univ. P. R. Agr. Exp. Sta. Bul. 86, 1950.
3. Bonnet, J. A., *et al.*, Annual report of the Department of Soils, Project S-14. Univ. P. R. Agr. Exp. Sta. (unpublished), 1955.
4. Bonnet, J. A., and Brenes, E. J., Salinity status of Lajas Valley soils, *J. Agr. Univ. P. R.* **41**(1) 25–34, 1957.
5. Bryant, J. C., Bendixen, T. W., and Slater, C. W., Measurement of water stability of soils, *Soil Sci.* **65** 341–5, 1948.
6. Jeffries, C. D., Bonnet, J. A., and Abruña, F., The constituent minerals of some soils of Puerto Rico, *J. Agr. Univ. P. R.* **37**(2) 114–39, 1953.
7. Lugo-López, M. A., Bonnet, J. A., and Pérez-Escolar, R., The effect of lime and synthetic soil conditioners on crop yields and soil aggregation, *J. Agr. Univ. P. R.* **41**(3) 179–88, 1957.
8. Pérez-Escolar, R., and Lugo-López, M. A., The effect of synthetic soil conditioners on soil-aggregate stability and production of potatoes and stringless beans, *J. Agr. Univ. P. R.* **41**(2) 127–33, 1957.

Effect of Incorporating Organic Materials into A Clay Soil of Lajas Valley on the Yields of Food Crops

J. A. Bonnet, M. A. Lugo-López, and M. Rico-Ballester[1]

INTRODUCTION

The beneficial effects of organic-matter additions to some soils have been generally recognized. In an intensive program of research geared towards the better utilization of the heavy soils of Lajas Valley, in semiarid southwestern Puerto Rico, where an irrigation project is under way, the possibilities of using organic materials for improvement of the soil physical conditions could not be overlooked. For this purpose organic materials may be advantageously used instead of the rather expensive synthetic soil conditioners.

The soils of Lajas Valley are deep and have an almost uniformly high clay content throughout the profile, and a rather slow permeability at the subsoil. Many of the present practical drainage problems are complicated by salinity and alkalinity hazards (*1*)[2]. Lugo-López, *et al.* (*8*) have reported that the application of synthetic soil conditioners to a clay soil in the Valley did not affect the yields of tomatoes, beans, and sweetpotatoes.

This paper reports on a field experiment designed to explore the possibility for soil improvement of organic byproducts of the sugar industry, such as filter-press cake and bagasse, together with a commercial source of an organic material.

MATERIALS AND METHODS

The experimental field was located on the Agricultural Experiment Substation farm near the town of Lajas in the semiarid southwestern region. The soil selected was a typical Santa Isabel clay, a compact soil of the terraces and alluvial fans (*11*). It is rich in feldspars of the oligoclase, albite, and labradorite types, and both kaolin and illite are the predominant clay minerals (*4*).

The experiment was laid out following a balanced incomplete-block design with seven treatments replicated six times in a 14-block arrangement. The plots were 4 feet × 6 feet in size. The treatments included the

[1] Head of the Department of Soils, Associate Soil Scientist, and Research Assistant in Agronomy, respectively, Agricultural Experiment Station, University of Puerto Rico, Río Piedras and Lajas, P. R. Appreciation is expressed to R. Vázquez, who helped in laying out the experiment in the field.

[2] Italic numbers in parentheses refer to Literature Cited, pp. 177–8.

following organic materials: Bagasse, filter-press cake, and a commercial organic product each at two levels, 20 and 40 tons of dry material to the acre. The organics were incorporated by hand-hoeing on June 2, 1954, into the topmost 6 inches of soil at the 20-ton level and to a 12-inch depth at the 40-ton level. Untreated control plots received the same hoeing treatment as the plots receiving organic materials at the rate of 20 tons per acre, *i.e.*, they were worked with hoes down to a 6-inch depth to minimize as much as possible any differences other than those imposed by treatment.

Three crops were grown on the same plots in the following sequence: Corn, white beans, and sweetpotatoes. The plots were irrigated whenever needed as indicated by a 9-inch deep-mercury tensiometer.

Corn, Mayorbela variety, was planted on June 8, 1954 at a 1½-foot distance between hills, three seeds to a hill. A 9–10–5 fertilizer was applied at planting time at the rate of 500 pounds to the acre, followed 21 days later by a side-dressing with ammonium sulfate. The plants were sprayed several times with a 4-percent solution of DDT and with Vapophos to keep pests under control. Corn ears were harvested on September 25 and October 4, 1954. The plots received a total of 31.5 inches of water, including 8 inches from irrigation.

White beans, Bonita selection, were planted on November 2, 1954 at a 4-inch distance between hills, three seeds to a hill, later thinned to two plants per hill. They received the same fertilizer as the previous corn crop, but at a rate of 800 pounds to the acre. Pests were kept under control by spraying thrice during the growing season with DDT at the same strength as was used with corn. The beans were harvested on January 17, 1955. The crop received a total of 6.5 inches of water including 2 inches from irrigation.

Sweetpotatoes, U.P.R., No. 3 variety, were planted on July 1, 1955. They were fertilized with an 8–8–13 fertilizer at the rate of 800 pounds to the acre. Several sprays with Aldrin, DDT, and BHC were required to keep pests under control. The crop was harvested on November 15–16. It received a total of 37.5 inches of water including 29.5 from rainfall fairly well distributed during the season.

RESULTS AND DISCUSSION

Data on the production of field corn, white beans, and sweetpotatoes as affected by the organic materials are presented in table 1. Highly significant differences were measured in the corn crop, the first in the sequence. The use of bagasse at rates of 20 and 40 tons to the acre and incorporated into the topmost 6 and 12 inches of soil, respectively, was detrimental to the growth and production of field corn. The germination of corn in the plots

where bagasse was incorporated was very poor and extensive replanting was needed. In these plots the plants were weak and chlorotic and did not develop and grow as well as the plants from other treatments. Side-dressing with ammonium sulfate at an early date was ineffective. This was because of the competition for nitrogen of the soil heterotrophic micro-organisms with the plant while decomposing an organic material such as bagasse, that has a wide carbon-nitrogen ratio. Filter-press cake and the commercial organic product used had a narrower C/N ratio, and consequently did not induce a competition between the micro-organisms and the plants.

TABLE 1.—*Mean yields of corn, beans, and sweetpotatoes in Santa Isabel clay with 3 organic materials incorporated at 2 depths*

Treatment No.	Soil treatment			Crop yields per acre		
	Organic material	Rate	Depth of incorporation	Corn	Beans	Sweetpotatoes
		Tons per acre	*Inches*	*Cwt.*	*Cwt.*	*Cwt.*
1	Filter-press cake	20	6	56.8	23.0	129.9
2	Bagasse	20	6	18.2	22.4	81.7
3	Commercial organic product	20	6	51.4	22.1	131.9
4	Filter-press cake	40	12	62.9	23.3	117.1
5	Bagasse	40	12	13.0	21.5	124.3
6	Commerical organic product	40	12	49.3	23.0	128.9
7	Check	0	6	47.5	21.8	107.3
L.S.D. at the 5-percent level				9.5	6.3	76.0
L.S.D. at the 1-percent level				12.8	8.4	102.4

Filter-press cake at the 40-ton rate significantly outyielded the bagasse at both levels, the commercial organic material at the higher level and the untreated plots.

The bean crop planted some 5 months after establishing the treatment differentials developed normally. No significant differences in yields of dry beans between treatments were measured. In general, the bean yields were rather good, over 20 hundredweights per acre. No significant differences attributable to treatment were measured in the sweetpotato crop, the third in the sequence, planted about 13 months after establishing the treatment differentials.

The effects of organic-matter additions to the soil on crop yields are dependent on several factors, such as nature of the soil, amount of organic

matter added, and activity of the organic materials (*5*). Lugo-López, *et al.* (*7*, *9*) have shown that additions of organic matter to normal latosols with open, porous structure are of rather doubtful value, while in heavy-textured humid-region nonlatosols such additions may result in increased organic-matter levels and better crop yields. Bonnet and Lugo-López (*2*), after a period of 13 months, found no increase in soil organic matter as a result of plowing under 5 to 10 tons of velvetbean green manure followed by two corn crops. No residual effect on yields of corn were observed in this field. When 25 tons of the green manure were plowed under a slight increase in organic matter was evident. Increases in organic matter and in sugarcane yields were measured after 6 years of continuous additions of sugarcane trash to a clay soil in the Río Piedras area (*6*, *10*).

The incorporation of velvetbean green manure in a latosol in the vicinity of Mayagüez did not produce an increase in organic matter, but caused significant yield increases of sweetpotatoes and corn (*3*). The response in yields may be attributable to a higher nitrogen supply from the activity of the legume. This nitrogen was used quickly by the growing crops. Such a rapid release of nitrogen with legume mulches under tropical conditions has been emphasized (*12*).

Organic-matter additions may play an important role in the reclamation, utilization, and conservation of many problem soils in the Lajas Valley. The establishment of a vegetation should receive also attention due to the role of roots in stabilizing soil structure, as a means of improving soil conditions for plant growth.

SUMMARY

Data have been presented here from a field experiment where bagasse, filter-press cake, and a commercial organic material were incorporated into a Santa Isabel clay soil under irrigation at the rates of 20 and 40 tons of dry material to the acre. The organic materials at the low level were hand-hoed into the topmost 6 inches of soil, while at the high level they were hoed to a 12-inch depth. Three crops: Corn, white beans, and sweetpotatoes, were grown consecutively in the sequence following the establishment of the treatment differentials. Bagasse, at both levels, depressed the yields of corn in a highly significant way. The use of filter-press cake at the rate of 40 tons to the acre outyielded bagasse at both rates, the commercial organic material at the high rate, and the check. No significant effects were measured on the bean and sweetpotato crops planted about 5 and 13 months, respectively, after establishing the treatment differentials. The growth of the latter was more uniform than that of corn.

The results are discussed briefly along with other results obtained under different conditions in Puerto Rico.

RESUMEN

Se presentan aquí datos sobre un experimento de campo en donde se incorporaron materiales orgánicos a un suelo Santa Isabel arcilloso bajo riego en el Valle de Lajas. Los materiales usados fueron bagazo, cachaza y un producto orgánico comercial. En unos tratamientos estos materiales se incorporaron a las primeras 6 pulgadas de suelo, a razón de 20 toneladas por acre y en otros, hasta 12 pulgadas de profundidad, a razón de 40 toneladas por acre.

Se sembraron y cosecharon consecutivamente maíz, habichuelas blancas y batatas mameyas en las parcelas después de la incorporación al suelo de los materiales orgánicos antes mencionados. La incorporación de bagazo al suelo, a ambos niveles, resultó en una reducción de los rendimientos de maíz. La cachaza, a razón de 40 toneladas por cuerda, resultó superior en su efecto al bagazo, a ambos niveles sobre la cosecha de maíz y también al orgánico comercial al nivel más alto y a la práctica corriente de no incorporar material orgánico al suelo. No se obtuvieron aumentos significativos en los rendimientos de las cosechas subsiguientes debido a los tratamientos. El crecimiento de estas fué más uniforme que el del maíz.

Los resultados obtenidos en este trabajo se discuten brevemente a la luz de la evidencia experimental previamente obtenida bajo otras condiciones en Puerto Rico.

LITERATURE CITED

1. Bonnet, J. A., and Brenes, E. J., Salinity status of Lajas Valley, *J. Agr. Univ. P. R.*, **41**(1) 25–34 1957.
2. Bonnet, J. A., and Lugo-López, M. A., Effect of different quantities of velvetbean green manure on corn yields in Puerto Rico, *J. Agr. Univ. P. R.* **37**(1) 96–101, 1953.
3. Bonnet, J. A., Tirado-Sulsona, P., and Abruña, F., Effect of lime-phosphorus and green manure on sweetpotatoes and corn grown in acid soils. *J. Agr. Univ. P. R.* **31**(4) 303–21, 1947.
4. Jeffries, C. D., Bonnet, J. A., and Abruña, F., The constituent minerals of some soils of Puerto Rico, *J. Agr. Univ. P. R.* **37**(2) 114–39, 1953.
5. Joffe, J. S., Green manuring viewed by a pedologist, Advances in Agronomy VII, (Norman, A. G., ed.) Academic Press Inc., N. Y. pp. 141–87, 1955.
6. Landrau Jr., P., and Samuels, G., The handling of sugarcane trash: I, Yields and economic considerations, *J. Agr. Univ.P. R.* **36**(3) 240–5, 1952.
7. Lugo-López, M. A., Bonnet, J. A., Hernández-Medina, E., Landrau Jr., P., and Samuels, G., Soil organic-matter levels and crop yields in Puerto Rico, *Soil Sci. Soc. Amer. Proc.* **18**(4) 489–93, 1954.
8. Lugo-López, M. A., Bonnet, J. A., Rico-Ballester, M., and Acevedo, G., Lack of response of some food crops to the application of synthetic conditioners to a clay soil in Lajas Valley, *J. Agr. Univ. P. R.* **41**(3) 167–72, 1957.
9. Lugo-López, M. A., Hernández-Medina, E., and Landrau Jr., P., Differential response of some tropical soils to additions of organic matter, *J. Agr. Univ. P. R.* **40**(1) 70–7, 1956.

10. Lugo-López, M. A., Landrau Jr., P., and Samuels, G., The handling of sugarcane trash: II, Effects of various practices upon soil properies, *J. Agr. Univ. P. R.* **36**(3) 246–54, 1952.
11. Roberts, R. C., Soil survey of Puerto Rico, USDA in cooperation with Univ. P. R. Agr. Exp. Sta., Series 1936(8), 1942.
12. Vicente-Chandler, J., Mulches, An important item in tropical agriculture, *J. Soil & Water Conserv.* **8**(3) 136–40, 1953.

Effect of Lime and Soil Conditioners on Crop Yields and Soil Aggregation

M. A. Lugo-López, J. A. Bonnet, and R. Pérez-Escolar[1]

INTRODUCTION

The use of lime in acid soils has always been considered a sound agricultural practice, but differential plant responses have been generally obtained. The recently developed synthetic soil conditioners are either calcium or sodium salts or organic polymers. There are a large number of formulations on the market most of which are either on the basis of a hydrolyzed polyacrilonitril polymer (HPAN) or of a modified vinyl acetate maleic acid (VAMA) compound. The information available so far indicates that the known synthetic soil conditioners stabilize the soil aggregates, but do not form them (*5*)[2]. Pérez-Escolar and Lugo-López (*6*) have shown recently that the water stability of the 1–2 mm. aggregates of Juncos clay, a Gray-Brown Podzolic soil, was increased by treatment with synthetic polymers. Potatoes increased in yield, but no response was obtained with stringless beans because of the increased stability of soil aggregates. Lugo-López, *et al.* (*4*) have reported on the effect of different synthetic conditioners on tobacco seedbeds.

This paper reports the data obtained from a field experiment designed to determine the effect of lime and synthetic soil conditioners on the production of three crops. Studies were also made on the effect of those conditioners on soil-aggregate formation and aggregate stability.

MATERIALS AND METHODS

The experimental field was located on the farm of the Agricultural Experiment Substation near the town of Corozal, in the humid mountainous interior of the Island (fig. 1). The soil was a nearly level Lares clay, a medium acid and friable Red and Yellow Podzolic (*7*) soil occurring in

[1] Associate Soil Scientist, Head of the Department of Soils, and Research Assistant in Soils, respectively, Agricultural Experiment Station, University of Puerto Rico, Río Piedras, P. R. Appreciation is expressed to the following staff members: H. Gandía, Associate Horticulturist, formerly in charge of the Corozal Agricultural Experiment Substation farm, for his general supervision of the fieldwork; R. Olivencia, formerly Research Assistant in Agronomy, for his participation in most of the fieldwork relating to the first 3 crops; A. Riera, Associate Chemist in Charge of the Central Analytical Laboratory, formerly with the Department of Soils; and J. P. Rodríguez, Associate Agronomist, who gave valuable help in connection with the first cotton crop. A. Rodríguez Cabrera, Associate Agronomist in Charge of the Corozal Substation, provided the rainfall data.

[2] Italic numbers in parentheses refer to Literature Cited, p. 188.

terrace formations and derived from material washed from the Lower Tertiary clays and shales. Mineralogical studies have revealed that feldspars are absent in this soil and kaolinite dominates the clay fraction (*3*). The exchange capacity ranges from 16 to 23 m.e. per 100 gm. of dry soil, and the clay content from 35 to 45 percent.

The experiment was laid out following a 4-by-5 duplicated almost balanced, rectangular lattice design, including 20 treatments (10 limed and

FIG. 1.—General view of the soil-conditioner and lime experimental field at Corozal, P. R., Dec. 7, 1953, with second crop in flower. Plots were only 6 by 4 feet.

10 unlimed) each replicated 10 times. The plots were 6 feet × 4 feet in size. Three soil conditioners were used: Formulations 6 and 9 of Krilium, dry powder, 100-percent active ingredient; and Aerotil, dry powder, 40-percent active ingredient. Each conditioner was used at three rates: 900, 1,800, and 3,600 pounds to the acre. The conditioners were applied on September 2 and 3, 1952, and were carefully mixed with the uppermost 6 inches of soil. The check plots received the same mechanical treatment as the treated plots to minimize any possible differences other than those imposed by other treatments. On October 1, 1952, the limed plots received ground limestone at the rate of 5 tons to the acre.

Five crops were grown on the same plots in the following sequence: Sweetpotatoes, cotton, cotton (ratoon crop), sweetpotatoes, and corn. Information on each of the crops as to planting and harvesting dates, varieties, and rainfall is reported in table 1.

Sweetpotatoes (first and fourth crops) were planted at the rate of 10,840 plants to the acre; the first crop received an 8–6–16 fertilizer at the rate of 600 pounds to the acre, while the fourth received a 14–4–7 at the rate of 680 pounds. Sealand cotton (second crop) seeds were scorched with concentrated sulfuric acid prior to planting; five seeds were set on each hill to allow thinning to two plants per hill. Twenty days after planting, an 8–6–10 fertilizer was applied at the rate of 800 pounds to the acre, followed

TABLE 1.—*General information on the crops grown in the lime and soil-conditioner experiment at the Corozal Substation*

Crop No. in sequence	Crop	Variety	Planting date	Harvesting date	Rainfall during growing period
					Inches
1	Sweetpotato	UPR No. 3	Oct. 9, 1952	Feb. 11, 1953	16.1[1]
2	Cotton	Sealand	Mar. 21, 1953	July 31, Aug. 5, 8, 11, 20, 26, and 28, 1953	37.6
3[2]	do.	do.	—	Jan. 12, 19, and Feb. 4, 1954	32.3
4	Sweetpotato	UPR No. 3	Feb. 20, 1954	June 23, 1954	16.2
5	Corn	Mayorbela	July 15, 1954	Oct. 18, 1954	24.8

[1] Records missing for Oct. 9 to 31, 1952.

[2] A ratoon crop.

by an application of 45 pounds of ammonium sulfate per acre about 40 days afterwards. A ratoon crop of cotton (third crop) was likewise fertilized, omitting the late dressing with ammonium sulfate. Corn (the fifth crop) was thinned down to two plants per hill and received a 9–10–5 fertilizer at the rate of 800 pounds to the acre. All other agronomic practices followed the official recommendations of the Station (*2*).

Soil samples were taken on December 1, 1953, from check plots and from those unlimed plots that received 3,600 pounds of conditioner per acre. These samples were taken when the second cotton crop was standing on the field, 9 months after the first sweetpotato crop was harvested, *i.e.*, approximately 15 months after the conditioners were applied.

Dry-aggregate distribution was obtained by passing the air-dry soil through a nest of sieves ranging from 0.5 to 5 mm. Aggregate stability was determined in the 2-to-0.5 mm. size according to a modification of the

method proposed by Bryant, Bendixen, and Slater (*1*). This procedure requires that the aggregates be soaked for 2 minutes and be submitted subsequently to wet screening for 15 minutes. The aggregates remaining in the 0.5-mm. sieve are oven-dried at 105°C. The percentage aggregate stability was determined by dividing this weight by that of the original aggregates.

TABLE 2.—*Dry-aggregate distribution in Lares clay from the soil-conditioner experiment at Corozal*

Treatment		Aggregates of indicated diameter in mm.—					
Conditioner	Rate per acre	>5	3–5	2–3	1–2	0.5–1	<0.5
	Lb.	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Check	0	51.5	14.6	5.3	13.8	8.5	6.3
Krilium 9	3,600	44.6	15.9	5.8	15.5	10.5	7.7
Krilium 6	3,600	42.3	16.2	7.0	15.2	10.8	8.5
Aerotil	3,600	42.2	15.8	6.3	15.5	11.3	8.9

TABLE 3.—*Water-stable aggregates on Lares clay as affected by treatment with soil conditioners*

Treatment		Water-stable aggregates, 2–1 mm.
Conditioner	Rate per acre	
	Lb.	*Percent*
Check	0	25.2
Aerotil	3,600	32.2
Krilium 6	3,600	48.3
Krilium 9	3,600	55.0

EXPERIMENTAL RESULTS

AGGREGATION AND AGGREGATE STABILITY

Table 2 presents the data obtained by dry sieving the Lares clay samples. No appreciable differences in aggregation attributable to treatment were measured. Large aggregates, over 5 mm. in diameter, made up approximately half of the whole soil, the 2–3-mm. aggregate-size fraction was the least abundant and there were not too many fine (0.5 mm.) aggregates.

Date on soil-aggregate stability are presented in table 3. The water-stable aggregates in the soil from control plots amounted to only 25 percent, increasing to 32 percent in the Aerotil-treated plots, and to 48 and 55 percent in the plots that received Krilium formulations 6 and 9, respectively. The mean differences in water-stable aggregates are very marked.

The effect of soil conditioners on the different crops is shown by the mean yields reported in table 4. Over-all significant differences were observed in the mean yields of both crops (Nos. 1 and 4) of sweetpotatoes. In the first crop and in the absence of lime, Krilium 9, at the rate of 1,800 pounds to

TABLE 4.—*Mean yields of 5 crops grown in acid Lares clay with soil conditioners and limed or unlimed*

Treatment identification No.	Treatment[1]	Rates per acre	Yields of indicated crop per acre				
			Crop 1, sweetpotato	Crop 2, cotton	Crop 3, cotton (ratoon)	Crop 4, sweetpotato	Crop 5, corn
		Pounds	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*
1	Check		115.5	13.7	3.5	69.1	4.7
2	Krilium 9	3,600	115.6	21.7	5.8	105.4	5.9
3	do.	1,800	139.4	20.1	4.6	107.4	4.3
4	do.	900	130.7	13.4	4.2	98.1	2.4
5	Krilium 6	3,600	122.5	15.3	4.7	116.3	13.5
6	do.	1,800	127.2	16.9	3.5	105.8	3.1
7	do.	900	128.1	19.2	4.6	100.4	6.2
8	Aerotil	3,600	143.3	12.6	5.0	101.8	2.5
9	do.	1,800	115.2	21.3	4.6	103.1	4.6
10	do.	900	129.6	18.6	4.9	94.7	1.6
11	Lime[1]		138.0	24.3	4.8	110.9	7.2
12	Lime + Krilium 9	3,600	140.2	26.1	4.9	141.1	7.3
13	do.	1,800	152.0	26.6	5.7	116.2	8.4
14	do.	900	135.6	24.4	5.2	113.7	6.3
15	Lime + Krilium 6	3,600	132.9	23.5	5.1	130.6	6.8
16	do.	1,800	161.3	24.3	4.9	132.2	7.1
17	do.	900	146.0	21.4	4.2	141.0	9.1
18	Lime + Aerotil	3,600	141.7	25.6	4.6	109.6	6.5
19	do.	1,800	142.1	27.5	5.3	120.8	10.3
20	do.	900	124.8	27.6	4.1	117.8	4.3
L.S.D. at the 5-percent level			20.3	4.7	1.8	28.7	5.4
L.S.D. at the 1-percent level			26.8	6.2	2.4	37.9	7.2

[1] Lime applied at a rate of 5 tons per acre in treatments 11 to 20.

the acre outyielded Aerotil at the same rate, Krilium 9 at the highest rate, and the check. The highest level of Aerotil outyielded those same treatments and also the highest rate of Krilium 6. In the presence of lime, Krilium 6 and 9 at the rate of 1,800 pounds outyielded the lowest level of Aerotil. Krilium 6 at the medium level also outyielded its highest level and the check. In the other sweetpotato crop, and in the absence of lime, all conditioner-treated plots, except the one with the minimum rate of Aerotil, outyielded the check. In the presence of lime, Krilium 9 at the maximum

TABLE 5.—*Mean yields of 5 crops grown on Lares clay, limed and unlimed, with soil conditioners, irrespective of rates*

Treatment	Yields per acre		L.S.D. at the indicated level	
	Unlimed	Limed	5-percent	1-percent
	Crop 1—Sweetpotatoes			
	Cwt.	*Cwt.*		
Check	115.5	138.0	20.3	26.8
Krilium 9	128.6	142.6	8.3	10.9
Krilium 6	125.9	146.7	8.3	10.9
Aerotil	129.4	136.2	8.3	10.9
	Crop 2—Cotton			
Check	13.7	24.3	4.7	6.2
Krilium 9	18.4	25.7	1.9	2.5
Krilium 6	17.1	23.1	1.9	2.5
Aerotil	17.5	26.9	1.9	2.5
	Crop 3—Cotton (ratoon)			
Check	3.5	4.8	1.8	2.4
Krilium 9	4.9	5.3	.7	1.0
Krilium 6	4.3	4.7	.7	1.0
Aerotil	4.8	4.7	.7	1.0
	Crop 4—Sweetpotatoes			
Check	69.1	110.9	28.7	37.9
Krilium 9	103.6	123.7	11.7	15.5
Krilium 6	107.5	134.6	11.7	15.5
Aerotil	99.6	116.1	11.7	15.5
	Crop 5—Corn			
Check	4.7	7.2	5.4	7.2
Krilium 9	4.2	7.3	2.2	2.7
Krilium 6	7.6	7.7	2.2	2.7
Aerotil	2.9	7.3	2.2	2.7
L.S.D. between any treatment mean and check at indicated levels for each crop:				
Crop 1			16.6	21.9
Crop 2			3.8	5.1
Crop 3			1.5	2.0
Crop 4			23.4	30.9
Crop 5			4.4	5.9
L.S.D. between any two treatments means at indicated levels, excluding checks, for each crop:				
Crop 1			11.7	15.5
Crop 2			2.7	3.6
Crop 3			1.0	1.4
Crop 4			16.6	21.9
Crop 5			3.1	4.2

level and Krilium 6 at the minimum level outyielded Aerotil at the maximum level and the check.

In the first cotton crop, the second in the sequence, highly significant differences in yields were measured which could be attributed to soil conditioners. In the unlimed plots, Krilium 9 at both the medium and highest levels, Krilium 6 at the lowest level, and Aerotil at the lowest and medium levels outyielded the check, the lowest level of Krilium 9 and the highest level of Aerotil, respectively. Krilium 9 and Aerotil at the medium level outyielded the highest level of Krilium 6; and the highest level of Krilium 9 outyielded the medium level of Krilium 6. In the presence of lime, none of the conditioners outyielded the check; but the lowest level of Aerotil outyielded that for Krilium 6.

In the second cotton crop, a ratoon, third in the sequence, yields dropped

TABLE 6.—*Effect of lime application to acid Lares clay on the mean yields of various consecutive crops*

Crop	Crop No. in sequence	Yield from indicated treatment per acre		L.S.D. at the indicated level	
		Unlimed	Limed	5-percent	1-percent
		Cwt.	*Cwt.*		
Sweetpotato	1	126.7	141.5	6.4	8.5
Cotton	2	17.3	25.1	1.5	1.9
Cotton (ratoon)	3	4.5	4.9	.6	.8
Sweetpotato	4	100.2	123.4	9.1	12.0
Corn	5	4.9	7.4	1.7	2.3

abruptly from approximately 17 hundredweights to the acre in the previous crop to 4 in the unlimed plots and from 25 to approximately 5 in the limed plots, irrespective of soil-conditioner treatments. Only the highest level of Krilium 9 outyielded that of Krilium 6 and the check.

In the corn crop, the fifth in the sequence, over-all mean differences were significant. Krilium 6 at the highest level outyielded the check and all other treatments in the absence of lime. In the presence of lime, only Aerotil at the medium level, outyielded the lowest level.

Table 5 shows the mean crop yields, comparing the general effect of each of the conditioners, irrespective of the rates used. In the first sweetpotato crop, in the absence of lime, differences were not quite significant, but they were significant in the other sweetpotato crop, the fourth in the sequence. In the cotton plant crop, in the absence of lime, the over-all effect of soil conditioners was significant, but not in the ratoon crop. In the corn crop, differences were not significant. Krilium 6 was significantly better than Aerotil in the last two crops and better than Krilium 9 in the last crop.

LIME AND CROP YIELDS

Differences attributable to the effect of soil conditioners were minimized in the presence of lime (table 5); generally the yields were higher in the limed plots. Lack of lime was a limiting factor for crop production in acid Lares clay.

The effects of lime applications upon sweetpotato, cotton, and corn yields are summarized in table 6. The mean yield differences are highly significant for all crops except for the ratoon cotton crop, the third in the sequence.

DISCUSSION

The data in table 2 support the hypothesis that the more commonly known soil conditioners do not form aggregates. No differences in degree of aggregation due to treatments were observed in the soils when sampled some 15 months after establishing the treatment differentials. However, rather large differences were measured in the water-stability of soil aggregates (table 3). The study of the effect of synthetic conditioners on aggregate stability was restricted in this work to soil from check plots and from those where the chemicals were used at the maximum rate. However, information from a somewhat similar experiment at Aibonito revealed increases in aggregate stability at all three levels of the same conditioners (*6*).

All the crops in the sequence, except the third—a ratoon cotton crop—showed good, although variable responses to the application of soil conditioners. Sweetpotato, a root crop, was more responsive to the structure improvement resultant from the use of soil conditioners; the cotton plant crop responded also. The use of lime in this acid soil produced by far the most satisfactory results. Crop yields were boosted to over 10 and 20 percent in the sweetpotato crops, over 45 in the first cotton crop, and 50 in the corn crop. Yield increases for all crops attributable to lime were observed either in the presence or absence of any conditioner, irrespective of the levels used.

Widespread use of synthetic soil conditioners in general farming is currently limited by their cost. For a long while they will be necessarily restricted to specialized uses, but they can be of value in problem soils. The stabilization of structural units promotes a rather favorable physical environment in the soil. It improves soil-moisture movement, insures adequate aeration, and favors root extension, thus allowing the plant to exploit a larger volume of soil in its search for vital nutrients and moisture. The differential response of plants to increased soil-aggregate stability must be recognized (*6*). The possibilities of using cheaper organic materials such as filter-press cake, bagasse, sawdust, and crop residues, for the improvement

of soil structural conditions rather than using the costly synthetic products must be investigated. Furthermore, lime is relatively inexpensive in Puerto Rico. If the yields of some crops in acid soils could be boosted by the use of lime, in addition to the regular rational fertilization, it does not appear that synthetic materials have economic possibilities.

SUMMARY

Data are presented here on the effect of synthetic soil conditioners on aggregation and aggregate stability of acid Lares clay and on their effect, with or without lime, on the yields of sweetpotatoes, cotton, and corn.

Three conditioners were used: Formulations 6 and 9 of Krilium, and Aerotil, dry form, each at the rates of 900, 1,800, and 3,600 pounds to the acre. There were 20 treatments: Check, lime, conditioners at three levels, and conditioners at the same three levels plus lime. The data presented indicate that these conditioners will stabilize soil structural units, but will not form them.

Five crops were grown as a sequence: Sweetpotatoes, cotton, cotton (a ratoon crop), sweetpotatoes, and corn. All crops, except the cotton ratoon, showed some response to the application of soil conditioners. Sweetpotato, a root crop, was more responsive; but the cotton plant crop responded also to stabilized good structural soil conditions.

The largest crop responses measured were in the limed treatments. Increases attributable to lime were obtained either in the presence or absence of synthetic soil conditioners. Liming and rational fertilization seems to be the key to increased productivity in some acid soils of Puerto Rico. The synthetic materials do not have practical possibilities in large-scale farming.

RESUMEN

Se presentan aquí datos sobre el efecto de acondicionadores sintéticos del suelo en la agregación y en la estabilidad de los agregados del suelo Lares arcilloso. Se analiza también el efecto de estos compuestos químicos y de la cal sobre los rendimientos de batata, algodón y maíz en un suelo ácido como el Lares arcilloso.

Los acondicionadores usados fueron Krilium 6 y 9 y Aerotil, cada uno a razón de 900, 1,800 y 3,600 libras por acre. Se incluyeron 20 tratamientos, a saber, testigo y acondicionadores a los tres niveles arriba mencionados sin cal y con cal, a razón de 5 toneladas por acre en cada caso.

Cinco cosechas consecutivas se produjeron en las parcelas después de establecer los tratamientos: Batatas, algodón, algodón (retoño), batatas y maíz. Todas las cosechas, excepto el retoño de algodón, respondieron en alguna forma a la aplicación de los acondicionadores sintéticos al suelo. La batata, una cosecha de raices comestibles respondió mejor, pero aún el

algodón de plantilla respondió satisfactoriamente a las condiciones mejoradas del suelo, motivadas por una mayor estabilidad de sus unidades estructurales o agregados.

Sin lugar a dudas, fué la cal la que provocó los mayores aumentos en los rendimientos, tanto en ausencia como en presencia de los acondicionadores sintéticos del suelo. El encalar los suelos ácidos, conjuntamente con un programa racional de abonamiento, es la clave para el aumento de la productividad en algunos de los suelos ácidos de Puerto Rico, en cuanto a cosechas como la batata, el algodón y el maíz. Bajo tales condiciones, los acondicionadores de suelos no parecen ofrecer posibilidades prácticas en las operaciones agrícolas en gran escala.

LITERATURE CITED

1. Bryant, J. C., Bendixen, T. W., and Slater, C. W., Measurement of water stability of soils, *Soil Sci.* **65** 341–5, 1948.
2. Compendio de recomendaciones para la producción de cosechas, Agr. Exp. Sta. Univ. P. R. Misc. Pub. 1 (revised) 1954.
3. Jeffries, C. D., Bonnet, J. A., and Abruña, F., The constituent minerals of some soils of Puerto Rico, *J. Agr. Univ. P. R.* **37**(2) 114–39, 1953.
4. Lugo-López, M. A., Bonnet, J. A., Amy, A. S., and Pérez-Escolar, R., Effect of soil-structure stabilizers on the production of tobacco plants in the seedbed, *J. Agr. Univ. P. R.*, **41**(3) 189–96, 1957.
5. Pearson, R. W., and Jamison, V. C., Improving land conditions for conservation and production with chemical soil conditioners, *J. Soil & Water Conserv.* **8**(3) 130–5, 1953.
6. Pérez-Escolar, R., and Lugo-López, M. A., The effect of synthetic soil conditioners on soil-aggregate stability and production of potatoes and stringless beans, *J. Agr. Univ. P. R.*, **41**(2) 127–33 1957.
7. Roberts, R. C., Soil survey of Puerto Rico, USDA in cooperation with Univ. of P. R., Agr. Exp. Sta. Series 1936 (8), 1942.

Effect of Soil-Structure Stabilizers on the Production of Tobacco Plants in the Seedbed

M. A. Lugo-López, J. A. Bonnet, A. S. Amy, and R. Pérez-Escolar[1]

INTRODUCTION

Surface-crusting is usually a problem of major importance in tobacco seedbeds. It interferes mainly with seedling emergence and to some extent with the subsequent growth and development of the young plants. In Puerto Rico, many soils used for tobacco seedbeds have a high clay content, and compact and crust rather badly, often exhibiting undesirable physical conditions (*4*)[2]. Now that synthetic soil-structure stabilizers have appeared in the market attention has been directed to their ability to decrease the surface-crusting of soils (*1*, *3*). Since 1952 considerable work along this line has been conducted in the major tobacco-producing areas of the United States (*2*).

This paper reports the results of two field studies designed to determine the effect of several polyelectrolyte soil-structure stabilizers on the emergence and survival of tobacco seedlings. Filter-press cake, a byproduct of the sugar mills which can be obtained free and worked into the soil at a relatively low cost, was included among the treatments to evaluate its effect and to provide a practical basis for analyzing the effects of the synthetic stabilizers.

MATERIALS AND METHODS

Two experiments were conducted, one in 1952–53 and another in 1953–54, at nearby sites on an acid Caguas clay loam at one of the Tobacco Substation farms, on the outskirts of Caguas. The plant beds in both cases were protected with cheesecloth and were irrigated by sprinkling whenever required. The 1952–53 experiment included five treatments in a Latin-square design. The plots were 3 by 8 feet. A 6–8–10 fertilizer was applied to the soil at the rate of 1,500 pounds to the acre and hydrated lime was used at the rate of 1 ton to the acre. The seed were sown during the last week of November and the harvest or pulling of seedlings began on Jan-

[1] Associate Soil Scientist, Head of the Department of Soils, Associate Agronomist in charge of the Gurabo (Tobacco) Substation, and Research Assistant in Soils, respectively, Agricultural Experiment Station, University of Puerto Rico, Río Piedras and Gurabo, P. R.

[2] Italic numbers in parentheses refer to Literature Cited, p. 196.

uary 14, extending until late in February. The materials applied were as follows:

1, None
2, Filter-press cake, 25 ton/A. (dry basis)
3, Krilium, formulation 6, 100-percent active ingredient, 3,600 lb./A.
4, Krilium, formulation 9, 100-percent active ingredient, 3,600 lb./A.
5, Aerotil, 40-percent active ingredient, 3,600 lb./A.

The synthetic conditioners, all in their powdered dry form, were thoroughly mixed with the topmost 3 inches of soil and the filter-press cake was worked into the surface 6-inch layer. The check plots received the same mechanical treatment as the stabilizer-treated plots to minimize any possible differences other than those imposed by the conditioners.

The 1953–54 experiment was laid out following a balanced incomplete-block design. The plots were again 3 by 8 feet. There were seven treatments each replicated six times. The materials applied were as follows:

1, None
2, Filter-press cake, 25 ton/A. (dry basis)
3, Krilium, formulation 6, 100-percent active ingredient
4, Krilium, formulation 9, 100-percent active ingredient
5, Aerotil, dry form, 40-percent active ingredient
6, Goodrite, K 700 WF, flakes, 87-percent active ingredient
7, Goodrite, K 700 S, liquid, 17.4-percent active ingredient

The synthetic stabilizers were applied on the basis of a 0.02-percent concentration, *i.e.*, a total of 60 pounds of active ingredient of each chemical to the acre. The treatments were applied on October 19, 1953, when the soil was almost completely dry. The filter-press cake (treatment 2) was worked into the top 6 inches of soil while the synthetic stabilizers were worked into the uppermost 1 inch of soil. The soil in the check plots was stirred to a 1-inch depth to minimize differences other than treatments. Sterile sand was used as a carrier for the dry powdered stabilizers (Krilium 6 and 9, Aerotil, and Goodrite K 700 WF) while the liquid Goodrite, K 700 S, was diluted in 1 gallon of water and sprayed finely over the surface. The seed were sown 3 days after applying the treatment differentials and the soil was irrigated through sprinkling afterwards. Before the application of the stabilizers, Aldrin was applied at the rate of 2 pounds to the acre and a 6–8–10 fertilizer over the surface at a rate of 1,200 pounds to the acre. Hydrated lime was applied as in the previous experiment. The first batch of plants was pulled on December 2, 1953, and the last on February 9, 1954, comprising a total of six pullings. A number of seedlings from the third pulling were planted under field conditions and observations were made as to setting, vigor, and development.

RESULTS AND DISCUSSION

Table 1 gives data on seedling production from the 1952–53 and 1953–54 experimental plant beds. There were highly significant differences among treatment means. No significant differences were obtained between the check, the filter-press-cake-treated plots, and the Aerotil-treated plots

TABLE 1.—*Mean number of tobacco seedlings obtained in 1952–53 and 1953–54 when soil-structure stabilizers were added to seedbeds*

Treatment	Rate	Seedlings per acre
	1952–53 Experiment	
	Lb. per acre	*Number*
Check	0	3,339,963
Filter-press cake	50,000	3,541,428
Krilium 6	3,600	2,876,775
Krilium 9	3,600	2,382,732
Aerotil	3,600	3,260,103
L.S.D. at the 5-percent level		398,138
L.S.D. at the 1-percent level		558,203
	1953–54 Experiment	
Check	0	497,310
Filter-press cake	50,000	820,380
Krilium 6	60	336,138
Krilium 9	60	673,002
Aerotil	60	842,160
Goodrite, flakes	60	870,656
Goodrite, liquid	60	941,440
L.S.D. at the 5-percent level		515,896
L.S.D. at the 1-percent level		692,259

However, all three outyielded the plots treated with both Krilium formulations. It must be recalled that the Aerotil contains only two-fifths of the same active ingredient as Krilium 9, hence, much less active chemical was actually applied when the experiment was laid out. Both Krilium formulations were highly detrimental to the emergence of tobacco seedlings in these experimental seedbeds. Rather large bare spots were observed in the plots adversely affected (fig. 1). The young seedlings, however, were healthy in all cases and were not adversely affected by treatment with any of the structure stabilizers tested.

The data obtained from the 1953–54 experiment are also summarized in table 1. Some significant differences could be detected upon statistical analyses of the data. Both Goodrite formulations were superior to Krilium 6 which seemed to exert harmful effects even at the low rates used (0.02-percent active ingredient in all cases) in this experiment.

As shown in table 2 the filter-press cake induced a quicker emergence and development of the seedlings (fig. 2). By the time of the second pulling,

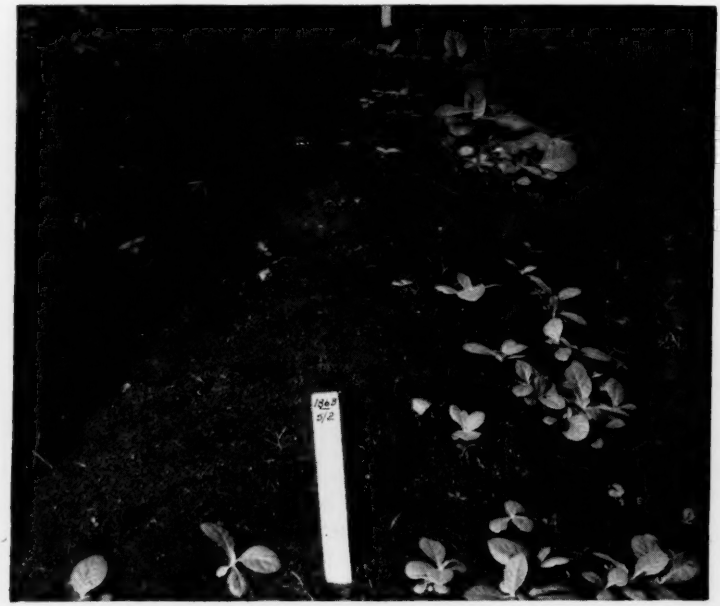

FIG. 1.—Large bare spots occurred in some of the conditioner-treated plots.

about 70 days following sowing, over 40 percent of the seedlings could be pulled from the filter-press-cake-treated plots, while only 20 percent could be pulled in the next best treatment, and only 7 percent in the untreated plots. These earlier maturing seedlings were also apparently healthier and more vigorous and their root systems were better developed (fig. 3). However, observations made from a selected group of plants that were transplanted to field conditions from each treatment failed to disclose any relevant differences as to survival, vigor, development, and production. Nevertheless, this earliness might be of tremendous practical and economic importance to the farmer, since field plantings must be established and

handled early in autumn in order to conclude the harvesting and curing during the spring.

An over-all examination of the data from both experiments suggests that the tobacco-seedling stands were somewhat adversely affected by some

TABLE 2.—*Influence of filter-press cake and synthetic soil-structure stabilizers upon the age at which seedlings could be pulled from seedbeds for transplanting to the field*

Treatment	Percentage of seedlings pulled at indicated age, in days					
	32	45	55	60	73	100
Check	1.5	5.8	41.3	21.0	16.8	13.6
Filter-press cake	15.1	27.8	33.8	10.4	5.8	7.1
Krilium 6	1.2	7.8	37.1	23.8	21.1	9.0
Krilium 9	2.8	14.6	45.1	17.4	9.2	10.9
Aerotil	5.0	12.5	41.3	19.9	9.6	11.7
Goodrite, flakes	4.2	16.4	45.7	16.5	8.5	8.7
Goodrite, liquid	2.9	9.5	45.1	17.5	10.6	14.4

FIG. 2.—Appearance of filter-press-cake-treated plant beds some 37 days after sowing.

of the synthetic soil-structure stabilizer treatments. This was particularly evident in the plots treated with both Krilium formulations at the high levels used in the 1952–53 experiment and in the Krilium 6-treated plots in the 1953–54 experiment. If Aerotil had been used at the same concentrations, on an active-ingredient basis, probably the same harmful effects would have been observed since it contains the same basic constituent as

FIG. 3.—Although the seedlings from the conditioner and filter-press-cake-treated plots seemed larger and with better developed root systems than those from check plots, no differences were observed when they were transplanted to field conditions: A, Check; B, filter-press-cake-treated; C, Goodrite-treated.

Krilium 9, although the difference in the carriers used as diluents might modify this effect considerably. The harmful effects of the stabilizers may be a reflection of the observed marked surface drying in the plots with a better soil structure.

It does not appear from these tests that these synthetic materials have economic possibilities in tobacco-plant beds. This is further emphasized by their almost prohibitive current prices. However, they might effectively reduce hard soil crusts, thus favoring seedling emergence, in soils with more acute crusting tendencies than the one where these tests were carried on.

For earlier maturing seedlings the use of filter-press cake should be advocated. It can be obtained free from sugar mills and incorporated into the soil at a reasonably low cost.

SUMMARY

Data are presented here from two experiments on the effect of synthetic soil-structure stabilizers and filter-press cake on tobacco seedbeds. The materials used in an experiment performed in 1952–53 were: None; 25 tons to the acre of filter-press cake; and Krilium 6, Krilium 9, and Aerotil, each at the rate of 3,600 pounds to the acre of the dry powdered form. In an experiment performed in 1953–54 the same stabilizers were used with the addition of Goodrite in both the flakes and liquid forms. However, all stabilizers were applied on the basis of a 0.02-percent concentration of the active ingredient. The number of seedlings obtained from the check plots, filter-press-cake-treated plots, and Aerotil-treated plots were significantly higher than those obtained from plots treated with both Krilium formulations in the 1952–53 experiment. Significant differences were measured in the 1953–54 experiment favoring both Goodrite formulations as compared with Krilium 6, at the low rate at which the synthetic stabilizers were applied. Filter-press cake seemed effective in inducing a quicker emergence and adequate development of the seedlings.

RESUMEN

Se presentan aquí datos de dos experimentos en los cuales se estudió el efecto de estabilizadores sintéticos de la estructura del suelo y de la cachaza en el desarrollo de las plantitas en semilleros de tabaco. En el primer experimento se usaron los siguientes tratamientos: Nada, 25 toneladas de cachaza por acre y Krilium 6, Krilium 9 y Aerotil, todos en forma de polvo seco y a razón de 3,600 libras por acre. En el segundo experimento, además de los productos antes mencionados se incluyó Goodrite, en sus formas de hojuelas y líquido; pero todos los estabilizadores se aplicaron a base de una concentración de 0.02 porciento de su ingrediente activo.

El número de plantitas obtenidas de las parcelas testigo y de las que recibieron cachaza o Aerotil sobrepasó significativamente el que se obtuvo de las parcelas tratadas con Krilium 6 ó 9 en el primer experimento. Se midieron diferencias significativas en el número de plantitas obtenidas en el segundo experimento las cualas favorecen el uso de ambas formulaciones de Goodrite, al compararlas con Krilium 6 a la concentración usada. El uso de la cachaza en los semilleros de tabaco parece eficaz, ya que induce una germinación más rápida y un desarrollo adecuado de las plantitas.

LITERATURE CITED

1. Heddrick, R. M., and Mowry, D. T., Effect of synthetic polyelectrolytes on aggregation, aeration, and water relationships of soils, *Soil Sci.* **73**(6) 427–41, 1952.
2. Jamison, V. C., Subcommittee reports on soil conditioners to the Southern Regional Soil Research Committee, 1952, 1953, and 1954 (mimeographed), Auburn, Ala.
3. Pearson, R. W., and Jamison, V. C., Improving land conditions for conservation and production with chemical soil conditioners, *J. Soil & Water Conserv.* **8**(3) 130–5, 1953.
4. Roberts, R. C., Soil survey of Puerto Rico, USDA in cooperation with Univ. of P. R. Agr. Exp. Sta., Series 1936 (8), 1942.

Residual Effect of Filter-Press-Cake Applications on Pineapple Yields

E. Hernández-Medina, A. Cruz-Miret, and M. A. Lugo-López[1]

INTRODUCTION

Extensive pot tests conducted in the open, the results of which are reported elsewhere (*1*, *2*)[2], have demonstrated the beneficial effect of filter-press cake upon pineapple yields. Subsequent work at two different locations has confirmed these previous results and shown that the use of filter-press cake under field conditions and in conjunction with fertilizer could be of considerable importance in reducing farm expenses, as well as in increasing crop yields and farm income (*3*). The beneficial effect of filter-press cake on crop yields has been partly explained on the basis of increased fertility level and improved soil physical conditions (*4*).

The practical value of the effect of filter-press cake under field conditions in warm tropical countries has not passed unquestioned. The main objection raised against its use is that its beneficial effects are of short duration because of the quick oxidation of organic residues in tropical soils. Such objection is probably valid if the effects of filter-press cake are to be considered over an extended period. However, the possibility still remains that filter-press cake may have some beneficial residual effect upon soils and crops during a limited period. It was this consideration which suggested the necessity of performing several experiments in the field in order to test the possible residual influence of filter-press cake on yields.

This paper reports data obtained from an experimental field at Arecibo where a study was conducted to determine the residual effect, if any, of filter-press cake applications upon the yields of a pineapple ratoon crop harvested 30 months after the establishment of the treatment differentials.

EXPERIMENTAL PROCEDURE

A summary of some of the relevant field information relating to this filter-press cake experiment at Palo Blanco, Arecibo, is given in the following

[1] Associate Horticulturist, Assistant Agronomist, and Associate Soil Scientist, respectively, Agricultural Experiment Station, University of Puerto Rico, Río Piedras, P. R.

[2] Italic numbers in parentheses refer to Literature Cited p. 201.

tabulation:

Item	*Information*
Experimental design	Incomplete block
Replications	8
Plot size	20 x 8 feet
Number of plants per plot	45
Pineapple variety	Red Spanish
Soil type	Bayamón silty clay
Number of treatments	13
Summary of main treatments	5 rates of filter-press cake, 3 rates of fertilizer, different number of applications, lime, and iron sprays.
Date of filter-press-cake application	Sept. 18, 1950.
Month of plant-crop harvest	Apr. 1952
Date of ratoon-crop harvest	Mar. 19, 27, and Apr. 10, 1953

Additional details for each soil treatment can be obtained from table 1.

TABLE 1.—*Mean pineapple yields per acre of the ratoon crop at the filter-press-cake experimental field, Palo Blanco, Arecibo*

Treatment identification letter[1]	Filter-press-cake application per acre	Fertilizer		Mean yield of fruit per acre
		Quantity per acre and analyses	Applications	
	Tons		*Number*	*Tons*
A	8	1,500 lb. 12–6–10	2	14.43
B	16	1,500 lb. 12–6–10	2	14.57
C	24	1,500 lb. 12–6–10	2	16.98
D	32	1,500 lb. 12–6–10	2	16.36
E	32	1,500 lb. 12–6–10	1	15.46
F	32	3,000 lb. 12–6–10	2	15.76
G	32	3,000 lb. 12–6–10	2	16.00
H	32	0	0	14.10
I	32	360 lb. NH_3 + 180 lb. P_2O_5	2	15.44
J	32	180 lb. P_2O_5 + 240 lb. K_2O	2	15.01
K	32	360 lb. NH_3 + 240 lb. K_2O	2	16.29
L	0	3,000 lb. 12–6–10	2	15.23
M	0	3,000 lb. 12–6–10 + lime[2]	2	15.45
L.S.D. at the 5-percent level				1.53
L.S.D. at the 1-percent level				2.03

[1] In all treatments, except F and L, 2 iron sprays were given to the plants as is customary in pineapple cultivation in Puerto Rico.

[2] Soil limed with an amount of calcium carbonate sufficient to raise the pH to 6.5.

The soil where the experiment was located has been classified as Bayamón silty clay, an acid, deep latosol of the northern coastal plains derived from limestone. The filter-press cake was 3 months old at the time of application and contained about 70 percent of moisture. It was worked into the top 4 to 6 inches of soil prior to planting the pineapple slips. The plant crop, details of which have been published elsewhere (*3*), was harvested in April 1952 when the plants were about 18 months old. The ratoon crop was then conditioned as is customary in commercial pineapple production, except for the fertilizer which was applied according to the treatment schedule. Fertilizer applications indicated were made on May 15 and October 15, 1952. Iron sprays were applied when required, that is, towards the middle of May and October of the same year.

To induce flowering the plants were treated with acetylene on November 15, 1953, some 5 months prior to harvesting. This treatment consisted in spraying the crown of the plant with 25 to 30 ml. of a solution made by dispersing 2 ounces of calcium carbide in 5 gallons of water in a closed container.

In March and April 1953, when the plantation was over 30 months old, the fruits were harvested as is usual in commercial practice. All fruits were weighed and the data on yield per acre were statistically analyzed.

RESULTS AND DISCUSSION

Data on mean yield of pineapple fruits per acre are given in table 1. A study of the data reveals that applications of 24 to 32 tons of filter-press cake to the acre, in conjunction with 1,500 pounds of a 12–6–10 fertilizer, were sufficient for maximum yields of a pineapple ratoon crop under the conditions that prevail at Arecibo. Complete omission of the fertilizer (treatment H) led to significant reductions in fruit yield even when the maximum quantity of filter-press cake was used (compare with treatments F and G). Thus it is evident that the use of filter-press cake alone is not a sound practice in pineapple fields.

Applications of a complete fertilizer at the rate of 3,000 pounds to the acre, even when filter-press cake was omitted (treatments L and M), were sufficient for relatively high yields. However, a consideration of the costs involved would favor the application of 24 to 32 tons of filter-press cake in conjunction with 1,500 pounds of fertilizer (treatments C to E) rather than the use of larger amounts of fertilizer without filter-press cake. The price of fertilizer and the expense of its application are rather high. On the contrary, filter-press cake can be obtained free from most sugar mills and hauled to the farm at a relatively low cost.

Whether the fertilizer was applied all at once or split into two applica-

tions had no effect on the final yields of fruits. Spraying with ferrous sulfate was not effective either. The supply of available iron in Bayamón silty clay was apparently plentiful enough for pineapple growth and production under the conditions in which this experiment was conducted. These results are in line with those obtained in previous experiments (*1*, *2*, *3*).

Table 1 further shows that single omissions of each of the major fertilizer elements, nitrogen, phosphoric acid, or potash (treatments J, K, and I, respectively) did not significantly reduce yields when filter press-cake was used. (Compare treatments J, K, and I with treatments F and G). Results from the plant crop were identical as far as phosphoric acid and potash are concerned. However, omission of nitrogen for the plant crop caused significant reduction in fruit yields (*3*). Perhaps the needs of well-established pineapple ratoon crops for nitrogen are less than those of the quick-growing young plants. Furthermore, there might be a more effective release of nitrogen from the filter-press cake as time advances.

All the results already discussed, except the ones concerning lack of response to nitrogen, confirm those obtained for the plant crop at the same location on the previous year (*3*). In Arecibo and related areas considerable savings can be made without reducing yields by using filter-press cake in conjunction with smaller doses of commercial fertilizers than those generally applied.

In the report issued about the results obtained from the plant crop it was stated (*3*):

> The economic implications of applying only half of the fertilizer generally used, when filter-press cake is available, can be far-reaching in areas where conditions similar to those around Arecibo prevail. About the same bulk of pineapple can be produced much cheaper by using 1,500 pounds of fertilizer and filter-press cake than when 3,000 pounds to the acre of fertilizer are used.

The results herein reported provide information of much practical value. The same previous statement concerning the plant crop holds for the ratoon crop harvested 30 months after applying the filter-press cake. The measurable beneficial effects of these treatments are gratifying. They guarantee sustained high fruit yields over a relatively long period including a complete 2-crop cycle. Whether or not these effects could be measured for longer periods is something which cannot be ascertained.

SUMMARY

Data are presented here on the fruit yields obtained from a pineapple ratoon crop at Arecibo where various rates of filter-press cake and fertilizers were tested. The filter-press cake was applied 30 months prior to harvesting the ratoon crop. The plant crop was harvested 12 months earlier. Fertilizer for the ratoon crop was applied after harvesting the plant crop. Pineapple

plants grown in soil receiving 24 to 32 tons of filter-press cake to the acre, in addition to 1,500 pounds of a 12–6–10 fertilizer, produced yields as high as, or even significantly higher than, plants growing in soil receiving twice as much fertilizer but no filter-press cake.

The possibilities of using filter-press cake more extensively in pineapple fields in the Arecibo area, in conjunction with smaller doses of fertilizers than are generally used, must be considered by growers. The residual effect of the filter-press-cake applications will reduce the fertilizer bill considerably in pineapple ratoon-crop cultivation.

RESUMEN

Se presentan aquí los datos de rendimiento de un retoño de piña sembrado en un campo experimental en Arecibo. En este experimento se estudiaron varios niveles de cachaza y abono, desde el punto de vista de su influencia sobre la producción. La cachaza se aplicó 30 meses antes de cosechar la fruta. Doce meses antes se había cosechado el fruto de la plantilla. El abono para el retoño se aplicó después de la plantilla.

Los rendimientos de las plantas de piña sembradas en el suelo que recibió de 24 a 32 toneladas de cachaza por acre junto con 1,500 libras de abono 12-6-10, fueron en algunos casos iguales y en otros significativamente superiores a los de las plantas sembradas en terreno donde se había aplicado el doble de la cantidad de abono antes mencionada, pero ninguna cachaza.

Los resultados de este experimento son económicamente significativos, ya que demuestran que es posible usar la cachaza de manera más ventajosa de lo que hasta ahora se ha venido haciendo. Esta afirmación cobra particular importancia si tomamos en cuenta el hecho de que con la cachaza y el abono usado en cantidades menores de las acostumbradas se consiguen rendimientos altos. No hay duda, pues, de que el efecto residual de las aplicaciones de cachaza reducirá considerablemente los gastos de abono en el cultivo de los retoños.

LITERATURE CITED

1. Hernández-Medina, E., The beneficial effect of filter-press cake on pineapple growth, development, and production: I, Effect on the plant crop, *J. Agr. Univ. P. R.* **36**(3) 255–80, 1952.
2. ———, The beneficial effect of filter-press cake on pineapple growth, development, and production: II, Effect on the ratoon crop, *J. Agr. Univ. P. R.* **36**(3) 281–301, 1952.
3. Hernàndez-Medina, E., Lugo-López, M. A., and Cibes-Viadé, H. R., The beneficial effect of filter-press cake on pineapple yields under field conditions, *J. Agr. Univ. P. R.* **37**(3) 206–12, 1953.
4. Lugo-López, M. A., Hernández-Medina, E., Cibes-Viadé, H. R., and Vicente-Chandler, J. The effect of filter-press cake on the physical and chemical properties of soils, *J. Agr. Univ. P. R.* **37**(3) 213–23, 1953.

Prevalence of Mosaic and Chlorotic Streak Diseases in the Sugarcane of Puerto Rico

E. Boneta García, P. González Ríos, and J. Adsuar[1]

INTRODUCTION

Such sugarcane diseases as mosaic and chlorotic streak constitute one of the main problems in sugarcane-growing in Puerto Rico. These diseases, especially mosaic, have at times in the past been a hindrance and are always a menace to the successful cultivation of this crop in Puerto Rico.

According to Chardón (*3*)[2] mosaic was first observed in Puerto Rico in 1915, by Stevenson in the Arecibo Valley. In a few years it covered practically the whole Island excluding probably the valley of Yabucoa. The industry suffered heavy losses because of the then mysterious disease. At that time, the sugar industry was on the verge of destruction. The introduction and propagation of mosaic-resistant varieties in Puerto Rico and the continuous "rogueing" of infected stools at that time preserved sugarcane-growing as a commercial farm enterprise.

It should not be assumed, however, that Puerto Rico is free from the disease, since the virus has been present all the time, ready to strike whenever a susceptible variety is propagated. Nevertheless, from the time of the original large-scale outbreak up to few years ago our sugarcane fields were almost free from mosaic disease.

SYMPTOMS

The outstanding feature that characterizes mosaic is a unique mottled pattern on the leaves of diseased plants, caused by a contrast of blotches changing in color from light-green to yellow against the normal green color of the remaining parts of the leaf. These blotches are irregular in size and shape, but generally appear along the length of the leaf which presents a somewhat striped appearance. The symptoms of the disease are more pronounced in the younger leaves. This condition causes a reduction in growth and sometimes death of the plant. The causal agent of the mosaic disease is a virus.

On the other hand, chlorotic streak disease was first observed in 1932 in Puerto Rico by Willbrink, Bell, and Martin (*5*). They regarded it as identical with a disease occurring in Java, Australia, and Hawaii. This disease is

[1] Agronomist Collaborator USDA, Head Agronomy Department, and Plant Pathologist, respectively, Agricultural Experiment Station, University of Puerto Rico, Río Piedras, P. R.

[2] Italic numbers in parentheses refer to Literature Cited p. 206.

characterized by the appearance of chlorotic streaks on the leaves which may vary in length from a few millimeters to the length of the entire leaf.

PROCEDURE

Considering the importance of the above-mentioned diseases on the sugarcane production of Puerto Rico, a general survey of their prevalence on sugarcane fields in the Island was conducted in 1955. All sugarcane areas in Puerto Rico were visited. This paper describes the actual abundance and distribution of both mosaic and chlorotic streak in sugarcane fields in Puerto Rico at the time of the survey.

MOSAIC

With the introduction of B. 34014, a very susceptible variety, mosaic infestation in the areas where it was grown became generally abundant. Increased acreage of this variety entails increased mosaic infestation in any area. However, because of its other good agronomic characteristics it soon became a favorite of a large number of farmers, especially in the eastern and southeastern regions of the Island. These geographical areas cover primarily the municipalities of Caguas, Gurabo, Juncos, Las Piedras, Humacao, Naguabo, Yabucoa, Maunabo, Patillas, Arroyo, Guayama, Aguirre, Salinas, Santa Isabel, and part of Ponce. Among these, mosaic is more predominant in Humacao, Yabucoa, Arroyo, and Santa Isabel where 100-percent infestation was observed in a plantation of B. 34104.

It is a fact that the mosaic-susceptible variety B. 34104 is being eliminated rapidly, but it is also true that some of the new varieties being planted are susceptible to the disease and, in many instances, the seed used for propagation comes from diseased fields. New plantings of B. 37161, also a susceptible variety, were observed at Barrio Tejas, Humacao, with about an 80-percent infection. The same situation was prevalent in other areas such as Aguirre and Santa Isabel in southern Puerto Rico.

Besides the infected fields of B. 34104 and B. 37161, plantings of other varieties, such as H. 328560 and B.H. 10–12 were found affected by the disease during the course of the survey. Although variety B. 34104, the extreme susceptibility of which undoubtedly has been the cause of the outbreak of mosaic in the above-mentioned areas, is in process of elimination, its scattered acreage still presents a menace as a source of infection, the virus being present and ready to strike other susceptible varieties of desirable agronomic characteristics. Such a situation was observed near Gurabo in a field of variety M. 336, planted near one of B. 34104 with 100-percent infestation, where many stools of M. 336 were already affected by mosaic.

Besides the badly affected areas in the east-central and southeastern

parts of the Island, isolated spots where the disease was present were also observed. In these places scattered stools of B. 34104 or other susceptible varieties like P.O.J. 36 were harboring the virus. This situation was observed near Carolina, Manatí, and in Central Soller in the vicinity of San Sebastián.

A comparison of the actual situation of the mosaic incidence in Puerto Rico with the epiphytotic of 1918, shows that the areas at present relatively free from the disease are those which were more severely affected in 1918.

CHLOROTIC STREAK

Chlorotic streak, another virus disease of sugarcane, is common in the northern part of Puerto Rico, where it can be found in almost every cane field. This disease is of great economic importance. It reduces germination and causes marked yield decreases in susceptible varieties (*1*). Chlorotic streak apparently spreads well under natural conditions. Its incidence appears to attain greatest intensity under conditions of heavy rainfall and poor drainage. Under these conditions the vector transmitting the disease (which so far has not been identified) seems to be more effective.

P.O.J. 2878, a mosaic-resistant variety, is susceptible to chlorotic streak and most of the fields planted to this variety are affected by the disease. At present this variety constitutes around 49 percent of the cultivated cane acreage in Puerto Rico (*6*). The low production of this cane can perhaps be ascribed largely to this disease. In addition to P.O.J. 2878 other varieties extensively grown in Puerto Rico are affected by the disease. Among them are M. 336, P.R. 902, P.R. 905, and H. 328560.

The presence of chlorotic streak was recorded in the rainy regions of the Island north of the divide from Mayagüez to Humacao. Throughout this area there were some spots that appeared to be more affected than others. In the areas near Canóvanas, Toa Baja, Vega Baja, Arecibo, Aguadilla, and Añasco the presence of the disease was more noticeable. Generally it was more prevalent and severe on heavy, poorly drained soils, where it helps to reduce germination, ratooning, and the total yield of the plantations.

SUMMARY

One of the problems facing sugarcane growers in Puerto Rico is the presence of sugarcane diseases such as mosaic and chlorotic streak. A general survey of the cane fields was conducted to determine the abundance of these diseases in Puerto Rico.

It was observed that mosaic was abundant in the east-central as well as the southeastern part of the Island. The abundance of mosaic in that por-

tion of the Island can be attributed to an increase in the cultivation of the very susceptible variety B. 34104. Although this variety is now being replaced by others, some of those being propagated in new plantings are susceptible to the disease. B. 34104 is still a menace to effective sugarcane growth in the areas where it has not been completely eradicated. Another factor that helps distribute the disease is the transportation of diseased seed to be planted in places where the disease is not found. Comparing the present mosaic situation with that in 1918, when the industry was on the verge of a complete collapse, we find that the areas that now appear to be relatively free from the disease are the ones that were more severely affected in the past.

Chlorotic streak disease is also present in Puerto Rico, being more abundant in the northern part of the Island. Its presence is most predominant in the rainy regions of the Island north of the divide from Mayagüez to Humacao. Probably the vector transmitting the disease is more effective in this area.

RESUMEN

Uno de los problemas principales que han tenido que afrontar los agricultores de caña de azúcar en Puerto Rico ha sido la presencia en sus cañaverales de enfermedades tales como el mosaico y la raya clorótica. Con el propósito de determinar la abundancia de estas enfermedades en Puerto Rico se efectuó un catastro general de las fincas de caña de azúcar. Se observó mucho mosaico en las regiones este-central y sur-este de la Isla. La abundancia de esta enfermedad en estas áreas puede atribuírse, mayormente, a un aumento en las siembras de la variedad susceptible B. 34104. Aunque al presente esta variedad se está eliminando, substituyéndola por otras variedades, algunas de las cuales son susceptibles a la enfermedad, todavía presenta ella una amenaza para la producción eficiente de la caña de azúcar en dichas zonas. Otro factor importante en la distribución del mosaico ha sido la transportación de semilla enferma hacia lugares libres de la misma. Si se comparan las condiciones actuales con las que culminaron con la epidemia del 1918, época en que la industria azucarera se encontraba al borde de un colapso total, se puede observar que las áreas que al presente demuestran estar libres de la enfermedad, eran las más afectadas en aquel entonces.

La raya clorótica, otra enfermedad de la caña de azúcar presente en Puerto Rico, se observó prominentemente en la parte Norte de la Isla. Su presencia es más notable en la región lluviosa del país, extendiéndose a través de la parte norte desde Mayagüez hasta Humacao. Probablemente el agente transmisor de la enfermedad es más eficiente en este área.

LITERATURE CITED

1. Adsuar, J., Chlorotic Streak Disease of Sugarcane in Puerto Rico, Agr. Exp. Sta. Tech. Paper No. 3, 12 pp. 1946.
2. Chardón, Carlos E., The varietal revolution in Puerto Rico, *J. Dept. Agr.*, **11**(1-4), 1927.
3. Chardón, Carlos E., Mosaic investigations at Central Cambalache, *J. Dept. Agr.*, **8**(1), 1924.
4. González Ríos, P., and Adsuar, J., Effect of mosaic on the yield of sugarcane variety B. 34104, *J. Agr. Univ. P. R.*, **37**(1) 13–8, 1953.
5. Landrau, P., and Adsuar, J., Effect of chlorotic streak on the yield of sugarcane, *J. Agr. Univ. P. R.*, **37**(1) 19–27, 1953.
6. Ríos, J. M., Bayrón, H., and Silva, E., Census of Sugarcane Varieties Grown in Puerto Rico in 1955–56 (In Spanish) Agr. Exp. Sta. Univ. P. R., November 1956.

Puerto Rican Neodexiopsis (Diptera: Muscidae: Coenosiinae)

Fred M. Snyder[1]

INTRODUCTION

The following species are described in order to have names to place on a valuable collection of *Neodexiopsis* Malloch made by J. Maldonado Capriles and associates.

The following commonly accepted abbreviations are used:

T1, T2, T3 = fore, mid and hind tibiae.
F1, F2, F3 = fore, mid and hind femora.

a = anterior	*v* = ventral
ad = anterodorsal	*av* = anteroventral
d = dorsal	*ia* = intraalar bristles
pd = posterodorsal	*st* = sternopleural bristles
p = posterior	*ac* = acrostical bristles or setulae
pv = posteroventral	*dc* = dorsocentral bristles

In describing the width of the front at vertex, the measurement is made at the level of the strong, upright pair of posterior parafrontal bristles and is compared with a measurement made at the widest part of the head. Width of the third antennal segment is the maximum anterior-to-posterior distance at right angles to the dorsoventral axis of the antennae when they hang ventrally. Length of the antennae is measured on the outer (lateral) surface when the head is viewed in profile. The head is described as viewed frontodorsally, except as noted, and the thorax and abdomen as viewed posterodorsally. There are several long bristles on the *a*, *ad* and *pd* surfaces of T3 which are important specific, generic, or subgeneric characters; there is a tendency for certain of these to vary slightly in position. All can be rationalized if the tibiae are assumed to be octagonal in cross section (*1*, *3*)[2]. In Nearctic species, the dorsal bristle, (*d*) is relatively short, and situated preapically; but in Neotropical species, it is frequently quite long and sometimes situated so close to the middle of T3 that it might be confused with either an *ad* or *pd* bristle. The use of the term, "mid *d*", is to qualify the position of this bristle as being on the midline of the *d* surface, and not midway from base to apex of T3.

Holotypes of the new species are deposited in the U. S. National Museum collection, though certain duplicate paratypes are retained in the author's collection.

[1] 8405 Loch Raven Boulevard, Towson 4, Md., U. S.

[2] Italic numbers in parentheses refer to Literature Cited, p. 229.

Grateful acknowledgment is made to C. W. Sabrosky of the U. S. Department of Agriculture for making this material available for study in connection with a proposed treatment of the New World species of *Neodexiopsis*. To F. van Emden of the Commonwealth Institute of Entomology, I am grateful for tracing specimens of *flavipes* Williston through the key, and to C. H. Curran of the American Museum of Natural History, I am also grateful for the loan of the type of his *rex* for study and comparison.

GENUS: NEODEXIOPSIS MALLOCH

Dexiopsis Stein, 1897, (*nec* Pokorny), Berliner Ent. Zeitschr., **42:** 259.

Neodexiopsis Malloch, 1920, Trans. Amer Ent. Soc., **46:** 162.

Coenosia (*Neodexiopsis*) Huckett, 1934, *op. cit.*, **60:** 73.

Coenosia Malloch, 1934, Dipt. Patagonia and South Chile, **7:** (2) p. 210, (in part).

Austrocoenosia Malloch, 1934, *op. cit.*, p. 217 (in part).

This group, as redefined by Huckett (1934, p. 74), differs from other *Coenosia* Meigen, *sensu lato*, in having three preapical bristles on F3: an *ad*, *d* and *pd* to *p* bristle. The position of the third bristle is quite variable, but is always situated on either the *pd* or *p* surfaces and in combination with two other apical bristles, which are situated somewhere between the *ad* and *d* surfaces, will distinguish this group from its closest relatives, *e.g.*, *Limosia* Robineau-Desvoidy, and *Coenosia* Meigen, *sensu stricto* (= *Caricea* Robineau-Desvoidy *of* authors).

Males of *micans* and *crassicrurus*, described below, lack this usual arrangement of F3 bristles due to the considerable modification of shape and accessory bristling of F3, but since associated females possess the typical three preapical bristles on F3, the two species noted above are included in *Neodexiopsis*.

Other peculiarities of several of the species in the collection are the atypical arrangment of sternopleural bristles which are not in the form of an equilateral triangle, the presence of a single postsutural intraalar bristle on each side, and the absence of duplicated propleural and stigmatal bristles. These characters, coupled with the extreme modification of certain leg bristles, femoral and tibial shape in some of the species, doubtless represent extreme evolutionary trends in isolated insular populations. More extensive collections from other Caribbean Islands will be necessary before relationships of these aberrant Puerto Rican species with North and South American species can be rationalized.

KEY TO PUERTO RICAN NEODEXIOPSIS

1. Apical scutellar bristles usually much less than 0.66 as long as subbasals 9

Apical scutellar bristles at least 0.75 as long as subbasals.....2

2. Postsutural *ia* 1.....*rex* Curran

Postsutural *ia* 2.....3

3. Males.....4

Females.....7

4. T3 with several rows of numerous, long, bristly hairs on *d*, *pd* and *a* surfaces, many of which are almost as long as length of T3; third antennal segment fulvous.....6

T3 with not more than 5 bristles, including apicals, and without accessory long, bristly hairs; third antennal segment dark.....5

5. Femora mostly or entirely fulvous; T3 without a submedian *av* bristle; abdomen with at least the basal portion of first visible tergite yellow to fulvous.....*discolorisexus*, new species

Femora mostly or entirely fuscous; T3 with a submedian *av* bristle or setula; abdomen entirely fuscous in ground color *ditiportus*, new species

6. Posterior margin of wing with a shallow longitudinal incision on basal 0.5.....*cavalata*, new species

Posterior margin of wing not incised.....*medinai*, new species

7. Femora mostly dark.....8

Femora mostly yellow to fulvous.....6

8. T3 with a median *av* bristle or setula; anterior ocellar bristles subequal to anterior parafrontals; trochanters dark *ditiportus*, new species

T3 without a median *av* bristle; anterior ocellar bristles less than 0.5 as long as anterior parafrontals; trochanters yellow to fulvous *discolorisexus*, new species

9. Postsutural *ia* 2.....10

Postsutural *ia* 1.....11

10. Antennae mostly or entirely fuscous.....*maldonadoi*, new species

Antennae mostly or entirely fulvous.....*neoflavipes*, new species

11. Males.....12

Females.....14

12. T2 with a single long *a* and *p* bristle slightly beyond middle; most of the apical bristles extremely long and hairlike; T3 without numerous, long, accessory hairs or bristles; with 2 stigmatal bristles *crispiseta*, new species

T2 with several long *a* and *p* bristles or hairs on apical 0.5; T3 with numerous long, accessory hairs or bristles; with a single stigmatal bristle.....13

13. T2 distinctly thickened on apical 0.4, with numerous, long, curly *ad* and *pd* bristles on this enlarged portion; in frontal view, the frons with dense silvery white pruinescence, the triangle not differentiated; abdomen with the usual dorsal pruinescence and clothing setulae *crassicrurus*, new species

T2 not unusually thickened on apical 0.4, with 1 *a* to *ad* bristle, and several *pd* on median 0.5; in frontal view, frons with dense brownish pruinescence, the triangle differentiated; abdomen shiny dorsally, without or with only sparse clothing setulae . . . . *micans*, new species

14. Palpi, fore coxae and basal 0.8 or more of F2 and F3 fuscous *ebenifemur*, new species

Palpi, fore coxae and basal 0.8 or more of at least F2 and F3 yellow to fulvous 15

15. Stigmatal and propleural bristles duplicated; F2 with 2 apical *p* to *pd* bristles . . . . . *crispiseta*, new species

Stigmatal and propleural bristles not duplicated; F2 with a single apical *p* to *pd* bristle 16

16. T2 with 2 submedian *p* bristles . . . . . *crassicrurus*, new species

T2 with 1 submedian *p* bristle . . . . . *micans*, new species

NEODEXIOPSIS REX CURRAN

Curran, 1928, Scientific Survey Puerto Rico and Virgin Islands, 11:88.

Male, 3.7 mm. long. Head black, with dense silvery gray pruinescence; the frontal vitta brownish gray pruinescent; the frontal triangle narrowly complete. Front at vertex 0.27 of head width, gradually widened to 0.30 at base of antennae. In profile, juncture of parafacials and parafrontals 0.5–0.8 as long as the greatest width of third antennal segment, parafacials obscured below. Cheeks 0.5 as high as width of third antennal segment. Anterior ocellars about 0.5 as long as postocellars, and the latter subequal to the anterior parafrontals. Inner verticals subequal to postocellars; outer verticals about 2 times as long as the setulae in postocular row. The setulose hairs on lower margin of cheeks and posterior portion of head yellow. Antennae dark; yellowish on basal 0.50–0.33 of third and at apex of second segments, all densely gray pruinescent; antennae inserted opposite dorsal 0.4 of eyes and extending almost to opposite their lower margin; third segment 3.0 times as long as second. Arista dark, subshiny, the longest hairs very slightly longer than greatest aristal diameter. Palpi light brown to dark yellow.

Thorax black; densely bluish gray to grayish pruinescent; presuturally with a trace of 3 brown vittae which become expansive, subconfluent and blend into a darkened area along *ia* plane postsuturally. Setulae on humeri and anterior declivities of mesonotum normal; *ac* setulae irregularly bi-

seriate; prescutellars scarcely differentiated; *ia* 1; the stigmatal and propleural bristles with a very slender, duplicating bristle. Apical scutellars as long as subbasals; *st* in an equilateral triangle.

Legs yellow, the tarsi and a limited dorsal apical area of F2 and F3 brownish. F1 normal, the few short *av* setulae at base not spinulose. T1 with a median *p* bristle; the mid *d* slightly longer than the *pd*, the former inserted only slightly based to the latter and both longer than T1 diameter; the apical *pv* about 0.5 the length of *pd*. F2 with a series of slender, apically curved, *av* bristles, those on basal 0.25 longer than F diameter and the others about as long as F diameter where situated; with 5–6 stronger *v* bristles, the basal 3–4 longest; and with 1–2 slender submedian *a*, and 2 preapical *p* bristles. T2 with a median *a* and *p* bristle; the apical *ad* not differentiated and the apical *pd* only slightly longer than T2 diameter. F3 with a row of slender apically curved *av* and *pv* bristles, several of which are longer than F diameter and others subequal to diameter where situated, but without a distinct apical *av* bristle opposite the terminal one in *ad* row. T3 with a median *ad* and *pd* bristle, the mid *d* situated on apical 0.20–0.25, the preapical *ad* about 0.5 as long as mid *d* and 2 times as long as T diameter.

Wings hyaline, with a very faint brownish tinge. Costal thorns and setulae short. Calyptrae white. Halteres yellowish white.

Abdomen elongate, somewhat broadened at middle and dorsoventrally thickened apically; fulvous yellow, with a dense, grayish pruinescent, triangular area at basolateral corner of all tergites; these areas largely devoid of clothing setulae; the dorsum of first 2 tergites subshiny yellow; the third and fourth mostly darkened dorsally, subshiny; with very short, dense decumbent clothing setulae on all tergites. Basal hypopygial segment grayish pruinescent, moderately distinct in profile, and with many, long yellow hairs on lower inner margins of third and fourth tergites.

Female, 4.5 mm. long. Head as in male, but pruinescence more cinereous gray; the fulvous area of antennae reduced to base of third segment. The anterior parafrontal bristle distinctly longer than the setula just behind it.

Thoracic pruinescence more cinereous gray and the vitta narrower and more well defined postsuturally than in male.

The preapical brownish area on F darker and more extensive than in male. F1 with *av* setulae somewhat stronger, but not spinulose. T1 with mid *d* and apical *pd* and *pv* shorter and stouter. F2 with 3–4 short *av* setulae on basal 0.5 and 4 widely separated *v* to *pv* bristles, a strong median *a*, and 3–4 shorter ones basad. F3 with *av* shorter, stouter, and less numerous than in male, but with some short, almost spinulose, interspersed setulae. T3 as in male, but the median *pd* absent.

Abdomen not as extensively yellow dorsally, and only the basolateral angles of first and second tergites fulvous, sparsely gray pruinescent, the

remainder of dorsum of these tergites subshiny black; third with a broad, subtriangular, median, subshiny spot, the lateral areas densely gray pruinescent; the fourth densely gray pruinescent, but with a narrow, dark longitudinal vitta.

SPECIMENS EXAMINED.—2 males, 3 females, El Yunque, P.R., March 20–22, 1954 (J. Maldonado and S. Medina); 1 male, Luquillo Nat. Forest, P.R., "11. 18. 1925, F5113A", (Holotype).

NEODEXIOPSIS DISCOLORISEXUS, NEW SPECIES

Male, 3.3 mm. long. Head black, with dense grayish pruinescence except on each side of the complete frontal triangle, where it is rather sparse. Front at vertex about 0.20–0.25 of head width[3]; juncture of parafacials and parafrontals narrowly projecting, parafacials obscured below. Cheeks about 0.5 as high as width of third antennal segment; with dark, bristle-like setulae along lower margin. Anterior ocellar bristles shorter than postocellars and anterior parafrontals; inner and outer verticals only slightly longer than setulae in postoccular row. Antennae dark, the apex of second segment somewhat grayish fulvous; inserted opposite dorsal 0.4 of eyes and reaching to opposite their ventral margin; third segment 3.0 times as long as second. Longest aristal hairs equal to greatest aristal diameter. Palpi dark brown to fuscous.

Thorax dark, densely grayish to bluish gray pruinescent, and with 5 well defined brown vittae which are in the *ac*, *dc*, and *ia* planes. Setulae in *ac* series biseriate, the prescutellar pair distinct and in almost the same longitudinal plane as the setulae; *ia* 2, subequal, well-defined. Humeral setulae normal, but more numerous than usual; setulae on anterior declivities of mesonotum normal, but with the accessory *dc* setula on the anterior margin somewhat more spinelike than usual; with 2 stigmatal and propleural bristles; apical scutellars strong; *st* in an equilateral triangle.

Legs yellow, usually with a faint to well-defined dark *pd* area on F1 and at apices of F2 and F3. F1 normal. T1 with a median *p* bristle, the mid *d*, apical *pd* and *pv* subequal, about 2 times as long as T1 diameter. F2 with 2–3 *a* and *v* bristles on median 0.5, and with 2 preapicals on *p* surfaces. T2 with a submedian *a* and *p*; the *a* situated apicad to the *p*; the apical *ad* usually undeveloped, but if slightly differentiated, then shorter than T1 diameter; the apical *pd* usually as long as T diameter and sometimes weakly duplicated. F3 with a complete row of *av* setulae which are about 0.50 as long as diameter of F3 where situated, but one near base, at middle, and apex is at least as long as F diameter; the *pv* surface with irregularly long and short interspersed bristles, but those on apical 0.20–0.25 more

[3] All males are slightly teneral or so covered with lepidopterous scales that exact measurement is impossible.

uniform in length and more closely placed than those on basal 0.80–0.75. T3 with a long median, and a shorter preapical *ad* bristle; the mid *d* inserted on apical 0.20–0.25 and closer to preapical *ad* than to the submedian *ad*; without submedian *pd* or *av* bristles.

Wings hyaline, often faintly tinged with brown. Costal thorns and setulae short. Calyptrae white. Halteres yellow to fulvous.

Abdomen with first 2 visible tergites predominantly yellow, the others dark in ground color. The first with a median dark area which blends into a dark triangular one on second; the dorsum of third mostly shiny black, and with a subtriangular, densely grayish pruinescent area basolaterally; the fourth mostly grayish pruinescent but with a narrow, subshiny median vitta.

Female, 4.5 mm. long. Generally similar to the male in structural characters, but much darker in color.

Head as in male. Thorax with *ac* and *ia* vittae broad postsuturally, and almost confluent with the *dc* vittae.

Legs mostly fuscous, the coxae, trochanters, apices of femora, and base of tibiae with limited reddish areas. F1 with *av* setulae on basal 0.5 stronger than in male; otherwise bristled as in male, except most of the F2 and F3 bristles and setulae stronger, and less hairlike.

Abdomen almost entirely fuscous, only the base of first visible tergite somewhat fulvous below.

TYPE MATERIAL.—Holotype, male, Kilometer 22, Yauco-Lares Road, P.R., July 18, 1953 (J. A. Ramos, J. Maldonado) at light; allotype, female, same data as type; paratypes: 7 males, 13 females, same data as type; 2 females, "Maricao S. Forest, P.R.", July 5, 1953 (J. Maldonado-Caprilles coll.); 1 female, "Maricao, P.R., Intercepted San Juan, P.R., 5–23–33, A. G. Harley, San Juan No 4243", and with a label in pencil, "USNM"; 2 females, El Yunque, P.R., March 20–22, 1954 (J. Maldonado and S. Medina); 1 male, Maricao Insular Forest, P.R., 30 April, 1953 (J. A. Ramos) (light trap), 1 female, Guilarte Park, Adjuntas, P.R., Feb. 13, 1954 (J. Maldonado and S. Medina); 1 female, Adjuntas, P.R., Feb. 13, 1954 (J. Maldonado and S. Medina); 1 female, "Yauco-Lares Rd., Km. 29", Jan. 20, 1954 (J. Maldonado and S. Medina).

NEODEXIOPSIS MICANS, NEW SPECIES

Male, 2.7 mm. long. Head dark; pruinescence on face and cheeks silvery gray; on occiput gray with a pale bluish tinge; frontal vitta brown to fuscous; frontal triangle brownish gray, extending to base of antennae as a narrow line. Front at vertex 0.27 of head width, slightly wider at middle, then narrowed to vertical width at base of antennae. Anterior and posterior ocellar bristles very short, subequal, not over 0.6 as long as the short an-

terior parafrontals; inner and outer verticals scarcely differentiated. Median parafrontal bristles strong, slightly longer than the posterior parafrontal bristle at vertex; the reclinate parafrontals as long as the anterior pair. In profile, juncture of parafacials and parafrontals subequal to width of third antennal segment; parafacials obscured below. Cheeks as high as width of third antennal segment, the setulae on their lower margin white; vibrissae dark. Antennae yellowish fulvous, but most of the dorsal apical portion of third and base of second segments dark brown. Antennae inserted opposite middle of eyes, reaching almost to their lower margin; third segment 2.0 times as long as second. Arista bare. Palpi silvery yellow, without distinct bristles but with short, pale clothing hairs.

Thorax black, bluish to greenish gray pruinescent; with a median brown vitta of variable width and indistinct brownish lines along planes of *ia* and *dc* bristles. Setulae on humeri and anterior declivities of mesonotum normal but sparse; *ac* setulae extremely short and almost uniseriate or absent; *ia* 1; with a single propleural and stigmatal bristle; *st* in an almost equilateral triangle. Apical scutellar bristles absent, or if apparently differentiated, then shorter than the very sparse scutellar clothing setulae.

Legs shiny yellow; the tarsi become darker brown from base to apex. F1 with a row of very short but distinct *av* spinules on apical 0.8; the *pv* bristles very slender and confined to apical 0.5; with the usual row of normal *pd* bristles. T1 with 4–7 long slender *p* hairlike bristles on apical 0.5, which become shorter apically, the longest at least 0.75 the length of T1; with a distinct preapical mid *d*, but without distinct preapical *pd* or *pv* bristles. F2 slender, almost bare, clothing setulae confined to *d* surfaces; with 1 short median *a* and a single hairlike *pd* on apical 0.25, and with 1–2 slender *v* hairs. T2 about 0.6 the length of F2, slightly bowed on basal 0.25 and with 4–5 long, hairlike *p* bristles which are about 0.6 the length of T2; with a single long *ad* bristle on apical 0.33; the apical *ad* absent; the *pd* short but distinct. F3 long and slender; almost bare, the clothing setulae confined to *d* surfaces; without a row of *ad* bristles, but with the preapical *ad* present; with 5–7 hairlike *pd* on apical 0.5 and with 1–2 short, slender *av* and 1 long *pv* at base. T3 0.6 as long as F3, straight; almost devoid of clothing setulae, but with a complete row of 10 or more long *av* bristles which are at least 0.33 the length of T3; with 2–3 slender but widely spaced *ad* and *pd* bristles, and a row of numerous long *pv* on basal 0.5; with 4–5 long *p* bristles along the entire length of T3; without well-defined *a* bristles. Most of the T bristles are slightly curled apically.

Wings hyaline, but light brownish tinged. Costal thorns and setulae very short. Posterior cross vein straight. Calyptrae white. Halteres yellow.

Abdomen cylindrical, as long as combined length of head and thorax; glossy yellow, except a large, dark, shiny area on sides of third and dorsum

of fourth visible tergites and with a median brown line on first and second. Clothing setulae reduced to 1–2 series on each side of the midline.

Female, 3.0 mm. long. Head as in male except the bristles along anterior portion of ventral margin of cheeks dark and those on posterior portion white; antennae darker.

Thorax as in male, but the median brown vittae more expansive postsuturally and confluent with the vittae in *dc* planes; and with an additional vitta in *ia* plane.

Only the fifth tarsal segment conspicuously darker than remainder of legs. F1 as in male. T1 with a single median *p*, and with apical *pd* and *pv* bristles distinct. F2 as in male, but not quite as slender, and the clothing setulae more numerous. T2 not bowed and with a single median *ad* and *pd* bristle. F3 with 2–3 *av* and *pv* bristles on basal 0.50–0.66 and with some very short interspersed setulae. T3 not bowed, with a single long, median *ad* and without *av* or *pv* bristles; the mid *d* bristle more basally situated than usual, inserted on apical 0.4 and the preapical *ad* bristle more than its own length from apex of T3.

Abdomen not cylindrical; dark, the yellowish areas restricted to basolateral portions of first tergite; densely grayish pruinescent and with an indistinct median brown stripe on first 3 tergites; with a transverse brown band at apex of first; the second to fourth tergites inclusive with a pair of subtriangular apical brown spots which extend ventrally onto sides of the second and third tergites.

TYPE MATERIAL.—Holotype, male, El Yunque, P.R., March 20–22, 1954 (J. Maldonado and S. Medina); allotype, female and paratypes: 1 male and 1 female, same data as type.

The males of *micans* and *crassicrurus* lack the usual arrangment of the apical *ad* to *p* bristles on F3, characteristic of *Neodexiopsis*. Because the associated females have these bristles in the typical *Neodexiopsis* arrangement, these species are included in this genus, especially since the males resemble *calopyga* Loew and *floridensis* Malloch, (*2*) in having the sides or more of the third and fourth abdominal tergites shiny.

NEODEXIOPSIS CRISPISETA, NEW SPECIES

Male, 3.1 mm. long. Head dark in ground color; grayish pruinescent, except the front which is densely brownish pruinescent and the parafrontals which are dark and scarcely differentiated. When viewed from above, the latter are yellowish gray pruinescent; the frontal triangle is faintly visible and reaches only midway to base of antennae. Front at vertex 0.24 of head width, amost parallel sided. In profile, parafacials and parafrontals scarcely visible. Cheeks 0.8 as high as width of third antennal segment, and with long, white, hairs on ventral portion. Anterior and posterior ocellar bristles

very short, about as long as the hairlike setulae which are interspersed between the usual strong parafrontal bristles; inner and outer vertical bristles scarcely differentiated. Antennae dark brown, but with a narrow yellow area adjacent to base of arista; inserted opposite middle of eyes and not reaching to their lower margin; the third segment 1.8 times as long as second. Longest hairs on arista almost as long as its greatest diameter. Palpi yellowish white.

Thorax black, bluish gray pruinescent; with a brown vitta along planes of *ac*, *dc*, and posthumeral to *ia* bristles; these vittae become more diffuse postsuturally and almost merge opposite the second postsutural *dc* bristle. Setulae on humeri and anterior declivities of mesonotum normal; *ac* setulae sparse, almost uniseriate; *ia* 1. Apical scutellars 0.4 as long as subbasals. Propleural and stigmatal bristles duplicated; the lower *st* bristle more posteriorly situated than usual.

Legs yellow, the coxae with a whitish tinge; the tips of F2 and F3 brown and the apical 2–3 tarsal segments blend into brown. F1 with the usual row of *pd*, *p* and *pv* bristles, but ventral 0.5 of *p* surface shiny and devoid of clothing setulae; without unusual *av* setulae. T1 with the median *p*, preapical *pd* and *pv* bristles 0.66–0.75 as long as T1, almost hairlike and slightly curled apically; the mid *d* bristle short, but somewhat more slender than usual. F2 with a complete row of slender, hairlike *av* bristles which are apically curved at their middle and are slightly longer than diameter of F2 where situated; with 4–5 moderately long *v* on basal 0.33 and with 6–9 long, curly *pv* bristles on basal 0.75, the median ones in this series at least as long as the length of F2; and with 1 long, and 1 short *p* preapical hairlike bristle. T2 with the *a* and *p* bristles more hairlike than usual and situated beyond middle; the apical *pd*, *p*, and *av* bristles very long and hairlike, somewhat crinkled, and at least 0.5 as long as length of T2; the apical *v* bristle normal; the apical *ad* bristle hairlike and only 2.0–2.5 times as long as diameter of T2. F3 with the *ad* row of bristles long, slender, and crinkled apically; with a complete row of 9–12 *av* and 5–8 *pv* hairlike bristles which are curled apically and are 0.33–0.67 as long as length of F3; the preapical *ad*, *d*, and *pd* bristles in the usual position for *Neodexiopsis*, but much longer and more hairlike than usual, their tips somewhat curled. T3 with an *a* bristle slightly basad the middle, a *pd* almost opposite it, and an *ad* on apical 0.33; another *ad* on apical 0.2, and a mid *d* bristle which is inserted almost at middle of T3; all of these very long and curled or crinkled apically, and almost as long as length of T3; clothing setulae normal and without interspersed long hairs.

Wings hyaline, faintly tinged. Costal thorns and setulae not unusually modified. Posterior cross vein straight. Calyptrae white. Halteres yellow.

Abdomen short, ovoid, and with large, shiny, triangular bare areas on sides of second to fourth visible tergites. The first 2 tergites yellow in

ground color but with a median, dark brown trapezoidal spot which is thinly overlaid with gray pruinescence; this spot on first tergite smaller than the one on second, and at apex of the latter the spots extend downwardly onto the side; the third and fourth tergites light brown with dense greenish to bluish gray pruuinescence on dorsum; with 3 large, irregular, brown spots on dorsum of third, and with 2 spots on fourth tergites.

Female, 4.3 mm. long. Head dark, grayish pruinescent; the front brownish pruinescent, and the cheeks with reddish to fulvous reflections. The frontal triangle indistinct and reaches only to middle of front, but when viewed from in front at various angles, the frontal vitta appears densely brown pruinescent and the posterior 0.5 of each parafrontal subshiny and slate gray. Front at vertex 0.20 of greatest head width, parallel sided. Cheeks 0.5–0.6 as high as width of third antennal segment; the hairs on its lower posterior portion yellowish. Anterior and posterior ocellar bristles subequal, and about 0.5 as long and strong as the rather long anterior parafrontal bristle; inner and outer vertical bristles scarcely longer than the setulae in postoccular row. Antennae fuscous, the base of third segment and apex of second narrowly fulvous; third segment 2.6 times as long as second. Palpi pale yellow, very slightly enlarged apically and with a fringe of slender, yellow, hairlike bristles along their lower margin. Otherwise head as in male.

Thorax dark, obscurely grayish pruinescent and with a trace of 3 narrow, brown vittae in *ac* and *dc* planes. Setulae in *ac* series short and sparse; the prescutellar pair scarcely differentiated. Apical scutellars 0.6–0.7 as long as subbasals. Thorax otherwise as in male.

Legs yellow, with a purplish brown *pd* cloud on F1, at apex of F2 and F3, and at base of mid coxae; the tarsi become more brownish from first to fifth segments. F1 with an irregular double row of very short, spinulose *av* setulae on basal 0.75. T1 with a median *p* and apical *pd* bristle almost 0.75 the length of T1; with mid *d* and apical *pv* conspicuously shorter, the latter 1.5 times as long as T1 diameter. F2 with a row of slender *v* to *pv* bristles, the 2–3 near the median 0.50–0.66 as long as the length of F2; with a median *a* bristle, a few much shorter ones basad and a single one beyond; with 2–3 preapical *p* bristles. T2 with a long, submedian *a* and *p* bristle; the apical *ad* not differentiated, but the apical *pd* longer than T diameter. F3 with 3–4 widely spaced, slender *av* bristles, one of them on apical 0.33 longer than the others and more dorsally situated, and with a short bristle opposite the terminal one in *ad* series; with 3–4 *pv* bristles on median 0.5, the median one longest. T3 with a long *a* on basal 0.33, an equally long *ad* slightly beyond middle and with a very short preapical *ad* which is scarcely as long as T3 diameter; the mid *d* as long as the *a* and inserted at middle of T3 and distinctly basad to the long *ad* bristle.

Wings as in male.

Abdomen apparently dark dorsally and yellow on ventral portions of sides; no marks visible, but the abdomen is greasy in the single specimen. TYPE MATERIAL.—Holotype, male, and allotype, female, El Yunque, P.R., March 20–22, 1954 (J. Maldonado and S. Medina).

NEODEXIOPSIS CRASSICRURUS, NEW SPECIES

Male, 2.8 mm. long. Head black; when viewed from directly in front, the face with extremely dense white, and the front with silvery, pruinescence; the parafrontals differentiated only when head is viewed from above. Facial plate not concave as usual and with a narrow longitudinal median ridge which extends from base of antennae to oral margin; the latter more ventrally extended than usual, and the lower margin of head distinctly constricted posterodorsally. In profile, juncture of parafacials and parafrontals as long as width of third antennal segment, the parafacials almost obscured below their center. The distance from vibrissae to nearest point of eye as long as length of third antennal segment. Hairs on ventral portion of cheeks short, white; vibrissae dark, only as long as anterior parafrontal bristle. Front at vertex 0.33 of head width, slightly wider at middle, then narrowed to vertical width at base of antennae. Anterior and posterior ocellar bristles 0.66 as long as the relatively short anterior parafrontal bristle, and about 0.4 as long as the median parafrontals. Inner and outer vertical bristles scarcely differentiated. Antennae inserted opposite middle of eyes and terminating opposite their lower 0.2, or about 0.66 the length of third antennal segment above oral margin. Antennae fulvous yellow, and with a darkened apical area on outer surface which extends almost to middle of third segment; first and second segments dark, but with a very narrow apical fulvous border on second; third segment 2.0 times as long as second. Arista bare. Palpi slightly enlarged apically and inwardly curved; yellowish white and with dense white pruinescence; without distinct bristles.

Thorax dark, blue to greenish gray pruinescent; with a narrow median brown vitta presuturally which becomes broader postsuturally and merges with a narrow vitta along planes of *dc* bristles; with a mere trace of a vitta in *ia* plane. Setulae on humeri and anterior declivities of mesonotum normal; *ac* setulae very sparse, in a single irregular row; *ia* 1; apical scutellars 0.4 as long as subbasals. Lower stigmatal bristles absent; *st* 1:2 and not in an equilateral triangle.

Legs fulvous, mid and hind coxae somewhat fuscous basally; apices of fifth tarsal segments, claws and pulvilli black. F1 somewhat more swollen on basal 0.5 and narrower on apical 0.5 than usual; mostly shiny and bare; the clothing setulae in only 1–2 irregular *pd* rows; the bristles in the *pd* row very short and sparse; the *pv* surface with an irregular double row of short, spinulose setulae on apical 0.5 and with a single row of shorter ones

on basal 0.5; with a complete row of *av* spinules. T1 with 2 long median *p* bristles and with several shorter ones which extend to apex, the latter setae about twice as long as T1 diameter. F2 shiny; clothing setulae confined to *ad* and *d* surfaces; with a single short *a* bristle on basal 0.33–0.50 and with very short, somewhat spinulose setulae along *av* and *pv* surfaces; without any preapical bristles on *p* surfaces. T2 very narrow basally, becoming thicker apically, so that the distal 0.25 is almost as thick as the basal 0.25 of F2; the enlarged portion of T2 with several *ad* and *pd* series of long, irregular hairlike setulae and bristles. F3 narrowed on apical 0.2 and somewhat more swollen on basal 0.8 than usual, shiny; clothing setulae confined to *ad* and *pd* regions and without the usual row of *ad* bristles, the *av* and *pv* surfaces with only very short, spinulose setulae, and without a clearly defined apical *av* bristle. T3 slightly bent on basal 0.25 and with an *ad* bristle at basal 0.25–0.33; a row of 5–6 long, curled, bristlelike *av* hairs; and with a row of long, curved *pd*, *p* and *pv* bristles which are longest on the basal 0.4–0.6.

Wings hyaline. Costal thorns and setulae short. Calyptrae whitish hyaline. Halteres fulvous yellow.

Abdomen subcylindrical; when viewed dorsally, with a dark median dorsal area which becomes broader apically on first and second visible tergites; the entire dorsum of third and fourth dark, but with a narrow, median brown vitta. Sides of first and second, and ventral portion of all tergites yellowish to fulvous. When viewed laterally, with a large irregular shiny area on first and second tergites; and darker narrower ones on basal portion of third and fourth; the gray pruinescence extends progressively more ventrad on sides of second to fourth tergites respectively. Dorsum of all tergites with the usual decumbent clothing setulae.

Female, 3.2 mm. long. Generally resembling male, but without the modified face and oral margin. Tibiae and femora not unusually modified in shape or bristling.

Front with grayish brown pruinescence; frontal triangle extends narrowly to base of antennae. In profile, parafacials and parafrontals mostly obscured, but their juncture clearly visible. Cheeks as high as width of third antennal segment. Fulvous area on the antennae limited to base of third and apex or more of second segments. Palpi slender, not apically bent; yellow.

Thorax marked and bristled as in male, except the apical scutellar bristles are scarcely differentiated; only 1 propleural bristle present.

Legs yellow, tarsi brownish. F1 with a row of short, weak spinulose *av* setulae on basal 0.8, but with the usual *av* and *pv* bristles; *p* surface shiny, without clothing setulae. T1 with a long median *p*, a shorter preapical mid *d*, and apical *pd* and *pv* bristles, the latter two about 2 times as long

as T1 diameter. F2 with sparse but uniformly distributed clothing setulae; a strong and a weak median *a* bristle, a slender *v* and a single preapical *p* bristle. T2 with a long median *a* and 1 long and 1 short median *p* bristle; the apical *ad* absent and the *pd* short. F3 shiny, with 2–3 short *av* and *pv* bristlelike hairs on basal 0.75 and with short, interspersed setulae; clothing setulae very sparse or absent on most of *a* and *p* surfaces. T3 as in female of *micans*.

Abdomen as in female of *micans*.

TYPE MATERIAL.—Holotype, male, El Yunque, P.R., March 20–22, 1954 (J. Maldonado and S. Medina); allotype, female and paratypes: 2 males, same data as type.

The presence of 2 *p* bristles on T2 in the above female specimen is very unique, and since there are several *p* bristles on T2 of male, I am associating the allotype with the males in the type series, despite the much shorter length of the apical scutellar bristles in the female.

NEODEXIOPSIS EBENIFEMUR, NEW SPECIES

Female, 3.1–3.3 mm. long. Head black, grayish pruinescent; the front brownish tinged and the frontal triangle narrowly complete. Front at vertex 0.24 of head width, slightly wider at middle, but narrowed to vertical width at base of antennae. In profile, parafacials and parafrontals almost or completely obscured; only their juncture slightly protruding. Cheeks 0.8 as high as width of third antennal segment. Anterior and posterior ocellar bristles subequal, the anterior one 0.6 as long as the short anterior parafrontal bristle. Inner and outer verticals about as long as anterior ocellar bristles. The fuscous antennae inserted opposite dorsal 0.4 of eyes and ending slightly above their lower margin; third segment 2.8 times as long as second. Longest hairs on arista slightly shorter than its greatest diameter. Palpi fuscous.

Thorax fuscous, grayish brown pruinescent; with traces of brown vittae in *ac* and *dc* planes. Setulae on humeri and anterior declivities of mesonotum normal; *ac* setulae very short and sparse, but with a well-defined and widely separated prescutellar pair; *ia* 1, or if 2, then the anterior one is scarcely differentiated from clothing setulae. Apical scutellars 0.4 as long as subbasals; with 1 long and 1 short stigmatal and propleural bristle; *st* 1:2, not in an equilateral triangle.

Legs black, the knees and basal portion of tibiae dark yellow to brown; the basal posterior surface of F3 and sometimes base of F1 and F2 shiny black, remainder of femora sparsely grayish pruinescent. F1 with a row of short and somewhat spinulose *av* setulae on basal 0.75–0.80. T1 with a long median *p* bristle; the mid *d* situated at apical 0.25, and is 2.5–3.0

times as long as the apical *pd* and *pv* which are only slightly longer than T1 diameter. F2 with 3–4 widely separated *v*, 2–3 submedian *a*, and 2 preapical *p* bristles. T2 with a strong median *a* and *p* bristle; the apical *ad* not differentiated, and the apical *pd* scarcely as long as T2 diameter. F3 with 1–2 strong *av* bristles at apical 0.33, and some short setulae basad; without an apical *av* opposite the terminal *ad* bristle; and with 3 long, slender *pv* bristles on median 0.5. T3 with the mid *d* bristle long and medianly situated, a long *ad* bristle basad to the middle, and another somewhat shorter one which is situated on apical 0.20; without *av* or *pd* bristles.

Wings grayish hyaline. Costal thorns and setulae short. Calyptrae concolorous with wings. Halteres fulvous yellow.

Abdomen somewhat elongate; fuscous; grayish pruinescent, and with a broad, brown, subtriangular band on apical 0.50–0.75 of first to third visible tergites; the fourth with only a median brown stripe.

TYPE MATERIAL.—Holotype, female, El Yunque, P.R., March 20–22, 1954 (J. Maldonado and S. Medina); paratypes: 1 female, same data as type; 2 females same data as type except, "J. Maldonado Capriles, coll.".

NEODEXIOPSIS DITIPORTUS, NEW SPECIES

Male, 3.00–3.25 mm. long. Head black, dull gray pruinescent; frontal vitta, except the incomplete frontal triangle, dull velvety black. Front at vertex 0.36–0.38 of head width, gradually narrowed to 0.30–0.33 at base of antennae; the face very slightly constricted opposite middle of third antennal segment. In profile, juncture of parafacials and parafrontals 0.75–0.90 as long as greatest width of third antennal segment, the parafacials obscured below. Cheeks 0.5 as high as width of third antennal segment. Anterior ocellar bristles stronger than anterior parafrontals and about as long as the reclinate posterior parafrontal pair; posterior ocellar bristles 0.4–0.6 as long as anterior ocellars; inner verticals shorter than outer pair and the latter about 2 times as long as setulae in the postoccular row. Antennae fuscous, inserted opposite dorsal 0.4 of eyes and extending to opposite their lower level, and also to oral margin; third antennal segment 4.0 times as long as second, retreating basally on the posteroventral margin, but not sharply pointed apically. Longest aristal hairs as long as, or slightly longer than, greatest aristal diameter. Palpi black.

Thorax black, dull grayish pruinescent; with a narrow median brownish to subshiny vitta, a narrower brownish one along planes of *dc* and a broader one in the *ia* planes but the width of vittae are quite variable. Sides of scutellum subshiny. Setulae on humeri and anterior declivities of mesonotum normal, but with a well defined accessory *dc* setula on the declivity; *ac* setulae biseriate, the prescutellar pair scarcely differentiated; *ia* 2,

strong, subequal; propleural and stigmatal bristles duplicated; lower *st* somewhat closer to posterior than to anterior *st* bristle. Apical scutellars strong.

Legs black, the tibiae with a variable basal portion yellow to brown, blending to fuscous apically. F1 normal, but with a few of the *av* setulae on basal 0.2 often slightly longer than other clothing setulae. T1 with a long median *p*; the preapical mid *d*, apical *pd* and *pv* subequal, 2–3 times as long as T1 diameter. F2 with a row of *a* bristles on basal 0.5, the apical one longer and stronger than others, and with a row of short, slender *v* to *pv* bristles on basal 0.66–0.75. T2 with a submedian *a* bristle and a slightly to distinctly more apically situated *p*; the apical *ad* shorter than T2 diameter or absent; the apical *pd* as long as, or longer than, T2 diameter. F3 with 2 *av* bristles on apical 0.2–0.3 and 3–4 much shorter ones on basal 0.25–0.33, the intervening area usually bare; with 1–3 slender *pv* bristles on median 0.5, the median one longest when more than 1 is present. T3 with a median *ad* bristle, a shorter *av* slightly apicad to the *ad*; the preapical *ad* about 0.5 as long as the mid *d* which is inserted at apical 0.20–0.15.

Wings hyaline, distinctly irridescent. The decumbent costal thorns and setulae about as long as costal diameter. The clothing setulae on wing membrane somewhat more conspicuous than usual, but not distinctly enlarged. Calyptrae white. Halteres yellow.

Abdomen elongate, ovoid; dark, sparsely gray to greenish gray pruinescent. The first visible tergite mostly shiny black, the second to fourth each with an expansive, trapezoidal, subshiny, dark spot which covers most of the dorsum except a basolateral gray pruinescent area; when viewed posterolaterally a trace of a dark, median vitta overlays the expansive dark spots. In profile, the basal hypopygial segment prominent, but not globular; with a single pair of discal bristles. Superior forceps light brown to fulvous.

Female, 3.30–3.75 mm. long. Very similar to male. Differs in having the widest part of front opposite the strong pair of median parafrontals, the front then narrowed to vertical width at base of antennae. The third antennal segment narrower, and usually not more than 3.8 times the length of second.

The tibiae, except base of fore pair, usually concolorous with femora. Femoral and tibial bristles longer and stronger.

Grayish pruinescent areas on basolateral portions of abdominal tergites somewhat more extensive than in male.

TYPE MATERIAL.—Holotype, male, "Km. 22, Yauco-Lares, Rd., P.R.," July 18, 1953 (J. A. Ramos, J. Maldonado), at light; allotype, female, same data as type; paratypes: 10 males, 22 females, same data as type; 1 male "Yauco-Lares Rd., P.R., Km. 29, Jan. 20, 1954" (J. Maldonado, S. Me-

dina); 1 female, Maricao Insular Forest, P.R., April 30, 1953, light trap, (J. A. Ramos).

This species is very similar to the widespread Nearctic and Neotropical *rufitibia* Stein (*5*, *6*, *7*); but differs in having the third antennal segment of male somewhat shorter and narrower; the abdominal spots more expansive, and the base or more of tibiae usually lighter colored. Eventually it may be found that *ditiportus* is a member of a cline, *sensu* Huxley, but until populations from other Caribbean Islands are available for comparison and for mating experiments, it is considered to be distinct from *rufitibia*.

NEODEXIOPSIS MEDINAI, NEW SPECIES

Male, 3.0 mm. long. Head dark, grayish pruinescent; the cheeks with somewhat fulvous reflections. Parafrontals and frontal triangle moderately distinct, the latter narrowly complete. Front at vertex 0.24 of head width, almost parallel sided. Parafacials and parafrontals scarcely visible in profile. Cheeks 0.5 as high as width of third antennal segment. Anterior and posterior ocellar bristles 0.5–0.6 as long as the pair of short anterior parafrontal bristles; inner and outer verticals scarcely differentiated. Antennae inserted opposite middle of eyes and extending to almost opposite their lower margin; the fulvous third segment 2.3 times as long as the light-tipped, dark, second segment; arista brown, except the fulvous first segment; the longest hairs 2.0 times as long as greatest aristal diameter. Palpi yellowish brown, darker at base.

Thorax dark, grayish pruinescent; with a median brown vitta, and a postsutural one in *ia* planes. Setulae on humeri and anterior declivities of mesonotum normal; *ac* setulae sparsely biseriate presuturally, and irregularly uniseriate postsuturally, the prescutellar pair distinct; *ia* 2, equal; stigmatals and propleurals 2; apical scutellar bristles about 0.8 as long as subbasals.

Legs entirely yellow. F1 normal but with a small *pv* area which lacks clothing setulae. T1 with the median *p* bristle very slender, the preapical mid *d* slightly longer and stronger than the apical *pd* and *pv* which are about 2.0 times as long as T1 diameter. F2 with 4–6 *v* to *pv* bristles which are longest just beyond middle; without *a* bristles or any preapicals on *p* surfaces. T2 with a median *a* and *p* bristle, the apical *ad* well developed, the *pd* not differentiated. F3 with a single preapical *av* bristle and a row of slender setulae basad to it which are 0.33 as long as F3 diameter where situated; with a long bristle on the apical 0.33 which is inserted on the lower 0.25 of the *a* surface and therefore appears to be a second, somewhat more *d* situated bristle in the *av* series; with 2–3 short *pv* setulae on apical 0.2 which are almost as long as diameter of F3 where situated. T3 with a row of *pv* to somewhat *v* bristles which become longer towards apex, the

longest about 0.5 the length of T3; and with numerous long, slightly curled *a*, *ad* and *d* bristles which become longer apically, the longest equal to T3 length.

Wings hyaline, very faintly tinged with brown; costal thorns and setulae short. Posterior cross-vein straight. Anal angle rounded, and posterior margin without an incision. Calyptrae whitish. Halteres pale fulvous yellow.

Abdomen short. In profile, the first 3 visible tergites greatly thickened dorsoventrally, the fourth strongly retreating anteroventrally. The first tergite entirely yellow. The second yellow on sides and at base above, but blending into gray, and with a median brown vitta and traces of a round brown, central spot on each side. Third and fourth tergites gray on dorsum and upper 0.5 of sides, remainder yellow; with a median brown vitta and a pair of brown spots on apical portions. In dorsal view, all tergites subequal in length. Hypopygium not prominent in profile.

Female, 3.5 mm. long. Head as in male, but third antennal segment with extensive dark areas at apex which are continued basally along dorsal surface; the posterior ocellar bristles distinctly longer and stronger than anterior pair. Apical scutellars as long as subbasals.

Tips of F2 and F3 with a very small brownish area and a faint *pd* cloud on F1. F1 with *av* setulae on basal 0.5 more spinulose than in male, and in 3 irregular rows. T1 with the bristles stronger. F2 with the median *a* bristle somewhat more ventrally situated; and with 2 strong preapicals on *p* surface. F3 with the *av* setulae longer than in male and with numerous short, interspersed, spinulose setulae; the preapical bristles more *av* situated than in male, but clearly differentiated from the apical *av*; and with 2–4 distinct *pv* on median 0.50–0.75. T3 without rows of long, curled bristles, but with a strong *a* on basal 0.33; with a long median *ad* and some adjacent clothing setulae slightly longer and more upright than usual; the preapical *ad* bristle 0.75 as long as the median one and situated at apical 0.33, the mid *d* long and situated slightly beyond middle of T3; without median *av* or *pv* bristles.

Abdomen more pointed than in male, and not dorsoventrally thickened; dorsum mostly grayish, but sides and ventral portion of tergites mostly yellowish; with an elongate median, brown subtriangular spot on dorsum of first and fourth.

TYPE MATERIAL.—Holotype, male, El Yunque, P.R., March 20-22, 1954 (J. Maldonado and S. Medina); allotype, female and paratype: 1 female, same data as type.

NEODEXIOPSIS CAVALATA, NEW SPECIES

Male, 2.9 mm. long. Similar to *medinai*, in most characters, but differs in having cheeks without fulvous reflections; third antennal segment 2.0

times as long as the entirely fuscous second, and ending distinctly above lower margin of eyes.

Thorax with the vittae wider, the postsutural *ac* setulae more regularly biseriate, and the apical scutellars as strong as subbasals.

Legs as in *medinai* except T1 without a preapical *pd* bristle.

Wings with basal angle truncate as in *females* of *ovata* Stein (*5*), but with a long, shallow incision along the basal 0.5 of posterior margin.

Abdomen not as extensively yellow as *medinai* and only the dorsum of first visible tergite yellow, but with more extensive bluish gray areas on sides of second to fourth tergites.

Female, 3.75 mm. long, very similar to the male, and also to the female of *medinai*; it differs from the latter in having the third antennal segment entirely fulvous yellow; *ac* setulae more numerous; and tips of F2 and F3 not darkened.

Posterior margin of wing with a shallower incision and the anal angle not as distinctly truncate as in male. Both sexes, therefore, differ from *medinai* which has no trace of a posterior incision and has the anal margin distinctly rounded in both sexes.

TYPE MATERIAL.—Holotype, male, El Yunque, P.R., March 20–22, 1954 (J. Maldonado and S. Medina); allotype, female, same data as type; paratype: 1 female, Maricao Insular Forest, P.R., April 30, 1953, light trap (J. A. Ramos).

NEODEXIOPSIS NEOFLAVIPES, NEW SPECIES

Male, 2.8 mm. long. Head dark; face densely yellow, front yellowish gray, and occiput grayish pruinescent; cheeks yellowish anteriorly, blending into gray posteriorly. Parafrontals slightly differentiated from frontal vitta; with a faint, narrow, but complete, frontal triangle which is best seen in dorsal view. Front at vertex 0.30 of head width, parallel sided. Anterior and posterior ocellar bristles short, 0.5 as long as the anterior parafrontals; the latter distinctly shorter than the median parafrontals; inner and outer verticals short but distinct and not quite as long as postocellars. In profile, juncture of parafacials and parafrontals projecting anteriorly a distance equal to 3.0 times the greatest aristal diameter; the parafacials narrowed to greatest aristal diameter below. Cheeks 0.5 as high as width of third antennal segment. Antennae bright fulvous to orange, inserted opposite middle of eyes and terminating slightly above their lower margin; third segment 2.0 times as long as second. First aristal segment orange, others dark brown; the longest hairs equal to greatest aristal diameter. Palpi slender, fulvous and with a few short, dark apical setulae.

Thorax dark, densely grayish to greenish gray pruinescent; with a narrow brown median vitta and another much fainter one along planes of *dc*, posthumeral and *ia* bristles. Setulae on humeri and anterior declivities of

mesonotum normal; *ac* setulae sparse, irregularly biseriate; *ia* 2; apical scutellars 0.20–0.25 as long as subbasals. Stigmatal and propleural bristles duplicated. Lower *st* somewhat closer to posterior than to anterior *st*.

Legs entirely yellow to fulvous yellow. F1 normal. T1 with the median *p* bristle very short, almost hairlike; mid *d* close to apex; the apical *pd* and *pv* hairlike, 1.5–2.0 times as long as T1 diameter. F2 with a complete row of 7–9 *v* to *pv* bristles which are pale, very slender and about as long as diamter of F2 where situated; without any *a* bristles; and with 2 preapical *p* bristles. T2 with the median *a* and *p* bristles very short, scarcely longer than T2 diameter; the apical *ad* and *pd* only slightly differentiated from clothing setulae. F3 with a complete row of short, fine *av* setulae which are not quite so long as diameter of F3 where situated, the apical one stronger and darker than others and situated opposite the terminal bristle in *ad* row; *pv* surface with a few of the clothing setulae at base slightly longer than usual. T3 with the median and preapical *ad* bristle about as long as T3 diameter; the mid *d* longer and situated on apical 0.33.

Wings hyaline, costal thorn and setulae short. Calyptrae whitish hyaline. Halteres yellow.

Abdomen short, somewhat ovoid and dorsoventrally thickened; yellow but with an extensive shiny dark area on sides of third and fourth tergites. Dorsum of fourth darkened, grayish pruinescent and with a pair of round dark spots; third with a pair of smaller preapical spots.

Female, 3.0–3.2 mm. long. Similar to male; front and face more grayish pruinescent and the parafrontals and the frontal triangle very distinct. Postocellar and vertical bristles stronger.

Thoracic vittae broader.

Legs as in male, except all tibial bristles longer and stronger. F2 with a strong median *a* bristle; a series of short, more *ad* situated ones on basal 0.40 which terminate in a slightly longer bristle. F3 with 4–5 widely spaced *av* bristles, and numerous short, intervening setulae; with 3–4 *pv* bristles on basal 0.5.

Abdomen more pointed than in male; yellow, and without shiny spots. Each tergite except fourth with a grayish brown apical band on dorsum which becomes more extensive from first to third tergites, so that it covers most of third, and extends ventrally onto sides of all tergites. Second and third tergites with a median stripe; third with indistinct paired brown spots as in male. Fourth tergite yellow apically, brownish gray basally but with paired brown spots as in male.

TYPE MATERIAL.—Holotype, male, El Yunque, P.R., March 20–22, 1954 (J. Maldonado and S. Medina); allotype, female, same data as type; paratypes: 3 females, same data as type; 1 male, Henry Barraks, P.R.

June 19, 1952 (F. S. Blanton); 1 female, Peñón del Collao, Salinas, P.R., at light, (J. A. Ramos and J. Maldonado).

NEODEXIOPSIS MALDONADOI, NEW SPECIES

Female, 3.0 mm. long. Head dark, grayish pruinescent but with slight yellowish reflections on face. Front at vertex 0.31 of head width, almost parallel sided; the face very slightly constricted at middle. The almost square frontal vitta with very indistinct brownish reflections, and when viewed anteriorly without a well-defined frontal triangle. Anterior ocellar bristles slightly longer than anterior parafrontals, and subequal to the predorsal, reclinate parafrontal bristles, the latter distinctly shorter than the strong, upright, posterior pair. Posterior ocellar bristles 0.75–0.50 as long as inner and outer vertical bristles respectively. In profile, juncture of parafacials and parafrontals scarcely protruding; the parafacials obscured below. Cheeks almost as high as width of third antennal segment. Antennae dark, but with limited, pale reflections at apex of second segment; the third 2.0 times as long as second. Antennae inserted opposite middle of eyes and reaching to opposite their lower margin. Longest hairs on arista 2.0 times as long as its greatest diameter or 0.25 as long as width of third antennal segment. Palpi black at apex, blending into brown at base.

Thorax cinereous; grayish pruinescent; with a narrow median vitta, another in planes of *dc* bristles and a very faint one in the *ia* planes. Setulae on humeri and anterior declivities of mesonotum normal, but with a differentiated anterior accessory *dc* setula; *ac* setulae regularly biseriate on pre- and postsutural portion; *ia* 2, subequal. Apical scutellars 0.4 as long as subbasals. Lower stigmatal bristle short, ventrally curved; propleurals 2. Lower *st* closer to the upper one than usual and the *st*, therefore, not in an equilateral triangle.

Legs fuscous, except the fulvous: Tibiae, a variable but much reduced apical region on F1, and all metatarsi. F1 with short *av* setulae on basal 0.5. T1 with a median *p*, well developed preapical mid *d* and a shorter but well defined, *pd* and *pv* bristle; the latter bristles distinctly longer than diameter of T1 where situated. F2 with 3–5 *a* bristles on basal 0.5 which become longer and somewhat more ventrally situated towards middle; only a few very short *v* to *pv* setulae; and 2 preapical *p* bristles. T2 with the median *a* and *p* bristles on same transverse plane, but the *a* bristle slightly longer than the *p*; the apical *ad* well developed and longer than *pd*, but shorter than other apicals, and all longer than T2 diameter. F3 with short, irregular *av* bristlelike setulae, but with an *av* bristle opposite the terminal one in *ad* row; with a short median *pv* bristle. T3 with an *a*,

ad, and *pd* bristle on almost the same transverse plane on basal 0.33; the mid *d* on apical 0.20; the preapical *ad* inserted closer to the mid *d* than to apex; and with a preapical *pd* bristle inserted midway between the mid *d* and apex of T3; without median or submedian *av* bristles.

Wings pale brownish hyaline. Costal thorns and setulae slightly differentiated, but not longer than diameter of costa where situated. Calyptrae white, the lower one 2.0 times as long as upper. Halteres yellow.

Abdomen dark, grayish pruinescent; with a median brown vitta on all tergites; a pair of well-defined spots on second and third, and a much smaller pair on first tergite.

TYPE MATERIAL.—Holotype, female, El Yunque, P.R., March 20-22, 1954 (J. Maldonado and S. Medina).

There is a superficial resemblance of *maldonadoi* to the Holarctic *Coenosia humilis* Meigen, (*2*) in general color and in the presence of an *a* bristle on T3. However, the arrangment of the apical F3 bristles characteristic of *Coenosia sensu stricto*, the narrower front, and absence of a *pd* bristle on basal 0.33 of T3 will readily separate *humilis* from *maldonadoi*.

SUMMARY[4]

Only one species of *Neodexiopsis* was known from Puerto Rico. The genus belongs to the Family Muscidae of the Diptera. The author describes 10 new species in the genus, namely: *Discolorisexus, micans, crispiseta, crassicrurus, ebenifemur, ditiportus, medinai, cavalata, neoflavipes*, and *maldonadoi*. A key for the identification of the species is included. This peculiar group of flies is limited to the higher altitudes of the Island, the species having been collected from the following localities: El Yunque Mts., Maricao Commonwealth Forest, and the mountainous Lares-Yauco area.

RESUMEN[4]

Solamente una especie de mosca del género *Neodexiopsis* ha sido informada de Puerto Rico. El género pertenece a la Familia Muscidae de la Orden de los Dipteros. El autor describe 10 nuevas especies, a saber: *Discolorisexus, micans, crispiseta, crassicrurus, ebenifemur, ditiportus, medinai, cavalata, neoflavipes* y *maldonadoi*. Se incluye en este trabajo una clave taxonómica para la identificación de las especies. Este interesante grupo de moscas vive en las alturas de la Isla y varias especies fueron recolectadas en las siguientes localidades: Las montañas de El Yunque, el Bosque Estatal de Maricao, y el área montañosa comprendida entre Lares y Yauco.

[4] Summary and Resumen prepared in Puerto Rico by Dr. L. F. Martorell of the Department of Entomology, Agricultural Experiment Station, University of Puerto Rico, Río Piedras, P.R.

LITERATURE CITED

1. Huckett, H. C., A Systematic Study of the Anthomyiinae of New York, with Especial Reference to the Male and Female Genitalia, Memoir 77, Cornell Univ. Agr. Exp. Sta., pp. 1–91, 1924.
2. —— A Revision of the North American Species Belonging to the Genus *Coenosia* Meigen and Related Genera (Diptera, Muscidae), pt. I, *Trans. Amer. Ent. Soc.*, **60** 57–118, 1934.
3. van Emden, F. I. Calyptrata (1), Section (a), Tachinidae and Calliphoridae, Handbooks for the Identification of British Insects, **10,** Diptera: Cyclorrhapha, Royal Ent. Soc. London, pp. 1–133, 1954.
4. Malloch, J. R. Muscidae: Diptera of Patagonia and South Chile, pt. VII, Fascicle 2, British Museum (Natural History), pp. 171–346, 1934.
5. Stein, P. Nordamerikanische Anthomyiden, Beitrag zur Dipterenfauna der Vereinigten Staaten, *Berl. ent. Ztschr.*, **42** (1897), 161–288, 1897.
6. —— Die Anthomyidengattungen der Welt, analytisch bearbeitet, nebst einem kritisch-systematischen Verzeichnis aller aussereuropaischen Arten, *Arch. Naturgesch.*, **83** (1917), 85–178, 1919.
7. —— Nordamerikanische Anthomyiden, 2 Beitrag, *Arch. Naturgesch.*, **84** (1918), 1-106, 1920.

(*Continued from inside front cover*)

Library

J. P. Hayes, (Miss) M.S., Librn.

Office of the Editor

E. Molinary Salés, B.S., Assoc. Ed.
T. Swann Harding, B.S., English Tech. Ed.

Cooperative ARS Research Project[4]

J. Vicente Chandler, M.S., Sup. Co-op. ARS Res. Project
F. Abruña, M.S., Soil Scient.
J. Figarella, B.S., Soil Scient.
R. Caro Costas, B.S., Res. Asst. in Soil Conserv.
S. Silva, Soil Sci. Aid.

Rum Pilot Plant

V. Rodríguez Benítez, M.S., Tech. Dir.
C. Aguilera Flores, B.S., Res. Asst. in Chem.
A. Belardo Yadós, B.S., Res. Asst. in Chem.
H. M. Brau, Ph.D., Chem. Eng.
B. Calderón Tomei[2], B.S., Res. Asst. in Bact.
B. M. Camacho, (Miss) B.S., Res. Asst. in Chem.
A. García Porrata[3], Ph.D., Assoc. Chem.
B. D. Mundkur, Ph.D., Assoc. Chem.
R. L. Ramírez, B.S., Res. Asst. in Chem.
R. D. Rivera, B.S., Res. Asst. in Chem.
L. E. Vázquez, (Miss) B.A., Res. Asst. in Bact.

School of Medicine

D. Fernández, (Miss) B.S., Asst. in Nutrn.
W. Torres, (Miss) B.S., Res. Asst. in Chem.

Service Department

M. C. Guevara, M.S., Admin. Asst., Head of Dept., Assoc. Agron.
A. Meléndez González, B.S., Assoc. Agron.
G. J. Rigau, B.S., Asst. Agron.
C. Rivera López, B.S., Asst. Agron. in charge of Sta. Farm.

Statistical Section

I. S. Bangdiwala, M.S., Assoc. Statisn., in charge
A. Cruz Miret, B.S., Asst. Agron.
N. Herencia García (Miss), B.S., Res. Asst. in Statis.
L. Vega Maldonado, (Mrs.) B.S., Res. Asst. in Statis.

Substations and Seed Farms:

Main Office Seed Farm Division
M. C. Guevara, M.S., Assoc. Agron., Head of Div.

Coffee Substation, Castañer
S. Rodríguez, M.S., Asst. Agron. Actg. in charge
R. Bosque Lugo, B.S., Res. Asst. in Agron.
G. M. Román Roca, B.S., Res. Asst. in Agron.
T. Singh, Ph.D., Asst. Hort.
J. Toro, M.S., Res. Asst. in Hort.

Corozal Substation
A. Rodríguez Cabrera, M.S., Assoc. Agr. in charge

Isabela Substation
A. Riollano, M.S., Agron. in charge
M. Avilés, M.S., Assoc. Agron., in charge Seed Farm
R. Abrams, M.S., Res. Asst. in Agr.
R. Gandía Caro, M.S., Res. Asst. in Agr.
G. C. Jackson, B.S., Res. Asst. in Hort.
A. Pérez, B.S., Res. Asst., in Agron.

Lajas Substation
A. González Chapel, M.S., An. Husb. in charge
L. Almodóvar, B.S., Res. Asst. in Agr.
I. Carlo, M.S., Asst. An. Husb.
F. Díaz, B.S., Res. Asst. in Irrign. Eng.
J. García Albino, B.A., Res. Asst. in Chem.
J. González, B.S., Res. Asst. in Agr.
R. Irizarry, B.S., Res. Asst. in Agr.
R. Mendoza Barbosa, B.S., Res. Asst. in An. Husb.
C. A. Ortiz Lugo, B.S., Asst. Agron.
J. Ortiz Vélez[2], B.S., Res. Asst. in An. Husb.
M. Rico, B.S., Res. Asst. in An. Husb.
M. Rojas, M.S., Assoc. An. Husb.
J. H. Sanfiorenzo, M.S., Res. Asst. in An. Husb.
J. Torres Mas, B.S., Res. Asst. in Agron.
R. Vázquez, B.S., Res. Asst. in Agron.
L. S. Willardson, M.S., Irrign. Eng.

Gurabo Substation
A. S. Amy, B.S., Assoc. Agron., in charge
C. González Molina[2], B.S., Res. Asst. in Agron.
L. López Matos, M.S., Asst. Plant Path.
M. Manzano, B.S., Asst. Biochem.
L. B. Ortiz, M.S., Asst. Agron.

---

[2] Leave to pursue studies.
[3] Other leaves.
[4] Collaborators, USDA.

VOL. XLI OCTOBER 1957 NO. 4

THE JOURNAL OF AGRICULTURE

of the

UNIVERSITY OF PUERTO RICO

UNIVERSITY OF NEBRASKA AGRICULTURAL LIBRARY APR 14 1958

SOME EFFECTS OF CALCIUM AND PHOSPHORUS FERTILIZATION ON THE YIELD AND COMPOSITION OF A TROPICAL KUDZU-GRASS PASTURE.....*Fernando Abruña and Jacinto Figarella* 231

FLOWER BEHAVIOR OF DIFFERENT AVOCADO VARIETIES GROWN IN PUERTO RICO

R. Abrams, W. Pennock, G. C. Jackson, and A. Pérez López 236

EFFECTS OF X-RAY RADIATION ON OAT SEED.....*Raul Abrams* 242

INHERENT NATURAL RESISTANCE OF WOODS TO THE ATTACK OF THE WEST INDIAN DRY-WOOD TERMITE, *CRYPTOTERMES BREVIS* WALKER.....*George N. Wolcott* 259

PUBLISHED BY
UNIVERSITY OF PUERTO RICO
AGRICULTURAL EXPERIMENT STATION
RIO PIEDRAS, P. R.

Entered as second-class matter June 1, 1953, at the post office at Río Piedras, under the Act of August 24, 1912, as amended by the Act of August 4, 1947.

AGRICULTURAL EXPERIMENT STATION

University of Puerto Rico, JAIME BENÍTEZ, M.A., Ll.M., *Chancellor*

Station Staff[1]

Arturo Roque, M.S.....*Director*
B. G. Capó, Ph.D.....*Assoc. Dir. for Research*

Agricultural Economics and Rural Sociology

D. Haddock[2], M.B.A., Econ., Head of Dept.
J. M. Ríos, M.S., Assoc. Rural Sociol., Actg. Head of Dept.
J. R. Calderón, M.S., Asst. Econ.
J. B. Candelas, B.A., Res. Asst. Econ.
J. Collazo Collazo, B.A., Res. Asst. in Rural Sociol.
L. R. Collazo Sainz, B.A., Res. Asst. in Rural Sociol.
G. Espinet, M.S., Res. Asst. in Econ.
G. González, B.S.A., Res. Asst. in Econ.
L. Hernández, M.S., Res. Asst. in Econ.
A. Lloréns, M.S., Res. Asst. in Econ.
S. Marxuach[2], B.A., Res. Asst. in Econ.
G. Miranda Marchand, B.A., Res. Asst. in Rural Sociol.
C. E. Montes, B.A., Res. Asst. in Rural Sociol.
R. Pedraza, B.A., Res. Asst. in Econ.
J. L. Quintero Alfaro, B.A., Res. Asst. in Econ.
O. Rodríguez García, B.A., Res. Asst. in Econ.
D. L. Rodríguez Pagán, B.S.A., Res. Asst. in Econ.
I. Serrano Rodríguez[2], B.A., Res. Asst. in Econ.
E. Silva, M.S., Assoc. Econ.
J. Soto Aguayo, Res. Aid in Agr. Econ.

Agricultural Engineering

A. Eschenwald-Hess, M.S., Assoc. Agr. Eng. and Head of Dept.
A. Gaud González, B.S., Res. Asst. in Mech. Eng.
R. Otero Dávila, B.S., Res. Asst. in Agr. Eng.

Agronomy and Horticulture

P. González Ríos, M.S., Agron., Head of Dept.
S. Alers Alers, B.S., Res. Asst. in Agron.
F. Aróstegui[3], M.S., Assoc. Agron.
E. Boneta[4], M.S., Agron.
H. Gandía, B.S., Asst. Hort.
E. Hernández, Ph.D., Assoc. Hort.
P. Landrau, Jr., M.S., Assoc. Agron.
J. H. López Rosa, M.S., Res. Asst. in Agron.
N. Márquez Lugo, B.S., Asst. Agron.
F. Méndez, M.S., Agron.
C. G. Moscoso, M.S., Asst. Hort.
W. Pennock, M.S., Hort.
J. P. Rodríguez, B.S., Assoc. Agron.
G. Samuels, Ph.D., Agron.

Animal Husbandry

L. Rivera Brenes, Ph.D., An. Husb. Head of Dept.
J. A. Arroyo, B.S., Res. Asst. in Chem.
C. M. Berrocal, M.S., Asst. Bact.
J. I. Cabrera, M.S., Assoc. An. Husb.
C. M. Coker, Ph.D., Asst. Parasit.
J. Herencia García, B.S.A., Res. Asst. in An. Husb.
J. D. Rivera Anaya, D.V.M., Vet.

Entomology

L. F. Martorell, Ph.D., Ent., Head of Dept.
A. Ayala Almodóvar, B.A., Res. Asst. in Nem.
S. Medina Gaud, B.S., Res. Asst. in Ent.
M. E. Pérez, Ph.D., Asst. Ent.
J. Román, B.S., Res. Asst. in Nem.
G. Steiner, Ph.D., Nematologist.

Food Technology Laboratory

F. Sánchez Nieva, M.S., Tech. Dir.
J. R. Benero, B.S., Res. Asst. in Chem.
L. F. Colón[3], M.S., Asst. Chem.
B. Galanes, (Mrs.) B.S., Res. Asst. in Chem.
A. García, (Miss) B.S., Res. Asst. in Chem.
M. Martínez, (Miss) B.S., Res. Asst. in Chem.
M. Matos Maldonado, B.S., Res. Asst. in Chem.

[1] As of April 1, 1957.
[2] Leave to pursue studies.
[3] Other leaves.
[4] Collaborators, USDA.

(*Continued on inside back cover*)